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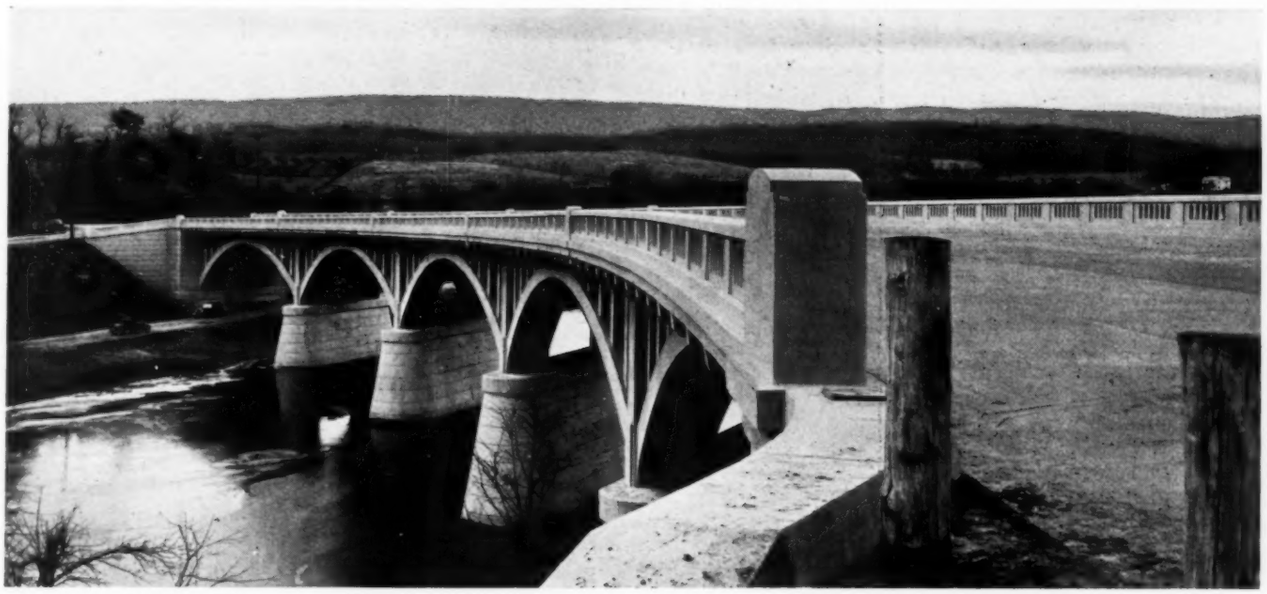

Spandrel Arch Bridge Carrying U. S. 30 Over Raystown Branch of Juniata River Near Bedford, Penn.

UNUSUAL BRIDGE ADDS TO ROAD SAFETY

By EMORY E. BRANDOW

Bridge Engineer,
Pennsylvania Department of Highways

ELIMINATING three sharp curves, a railroad grade crossing and the use of a narrow bridge, the new Bedford Narrows Bridge over the Raystown Branch of the Juniata River near Bedford, Penn., eliminates serious hazards of the heavily traveled Lincoln Highway.

The bridge consists of 5 spans with an over-all length of 583 ft. on the center line. Maximum height from foundation to grade is 62 ft. The roadway is 42 ft. between curbs, with a superelevation of ½ in. per foot. Crown of roadway is omitted. The structure is designed for H-20 live load.

The design of the bridge presented an interesting combination of three problems: the center line of the roadway is on a 5 degree 30 minute curve the full length of the bridge; the roadway is superelevated; and the structure is on a 2½ per cent grade, except the arch spanning the railroad which is on a vertical curve.

Substructure.—Foundation conditions presented a perplexing problem. At most footings subsurface explorations showed great variations of the elevation of good foundations within the limits of the individual footings. These conditions were taken care of by excavation under the footing in steps to a minimum of 1 ft. 6 in. below the top of solid rock between lines 1 ft. outside of the footings and replacing all excavated material up to the designated footing elevations with concrete.

The abutment units for the two arch ribs were constructed separately, and the fill between is retained by a curtain wall. These walls are offset to the rear of the faces of abutment units in order to take advantage of the steep rock slope found there.

At the east abutment, the approach fill is retained on the south side by a wing wall parallel to the center line of roadway. On the north side where the connec-

tion to the existing Lincoln Highway is located, the wing is constructed radial to the center line of roadway and extends to the limits of the connecting highway.

The west abutment has a wing similar to that on the east abutment for the connecting highway to Rainsburg. The wing on the north side, however, was located parallel to the railroad rather than the highway.

The piers are located so that they are approximately parallel to the flow line of the river and no two are parallel. They are made broad enough to keep the resultant at all elevations practically within the middle third, in order to conform to the design assumption of fixity at the arch ends. After a study of the comparative costs of constructing individual piers for each arch rib and combined solid or cellular piers for both arches, the cellular type was used in the pier adjoining the railroad and the solid type for the river piers.

Superstructure.—Two arch ribs 7 ft. wide carry the spandrels and floor system. The location of the piers to fit the waterway necessitated the use of an arch of 119 ft. center to center of piers on the north side and one 114 ft. center to center of piers on the south. The center lines of ribs are chords of circles concentric with the center line of roadway, one 12 ft. north of the center line of roadway, the other 14 ft. south of it. This variation of these distances makes the overhang of floor system approximately the same on the north side of the bridge as it is on the south. The skew backs are splayed to suit the angle between ribs of adjacent spans.

The arch ribs over the railroad are unsymmetrical. On the north side they have a theoretical span of 110.5 ft. and rise of 14.2 ft.; on the south side a span of 105.5 ft. and rise of 12.9 ft. The remaining arch ribs are symmetrical and have corresponding span lengths. However, the rise of the north ribs is 15.7 ft., and that of the south ribs is 14.2 ft.

In constructing the arch ribs voussoirs approximately equal to the distances between spandrel piers were poured with closing sections at the skew backs and crown poured last.

The spandrel consists of 2 by 6 ft. piers with no bases or capitals, supported by the arch ribs. At the piers heavy pylons were erected over the skew backs to the bottom of the floor system. Instead of jack arches at the top of the spandrel piers, a beam with bottom parallel to center line grade was used, because of the variation in spacing of the piers.

The floor system is more or less unique for arch construction since steel I-beams were used to support the concrete floor slab. The steel beams were provided because of the limited head-room over the railroad. They also had the following additional advantages: No separate detail required for the variation of span and overhang; available for use as trestling and centering until placed in final position; and support for floor system forms, and construction equipment. Furthermore, by locating the center line of steel beam at the center line of roadway when placing them in final position, the curve of the parapet and curb were definitely located. All beams are approximately radial.

Radial expansion joints were placed at all beams adjacent to pier pylons. The floor slab expansion is between steel plates, one anchored to the slab, the other riveted to the floor beam.

Architecture.—Since the bridge is curved it would give a feeling of being complicated even with the simplest of lines, so the entire bridge is designed to give simple, bold outlines. No architectural ornamentation was used except for the rustication of the faces of the piers and abutments. The parapets follow the Pennsylvania Department of Highways' standard.

The bridge was designed and constructed under the direction of the Department of Highways. The Pitt Construction Co. of Pittsburgh was the Contractor and the cost of the construction was about $230,000.

Stabilized Soil Road Withstands Erosion

How stabilized soil road surfaces withstand the erosive effects of torrential rains is graphically portrayed in this view of an Indiana road. Note how the wearing course, stabilized with binder soil and calcium chloride, remains intact while the shoulders of the road have been washed away. The picture was taken following a rainfall of 5.78 inches within 24 hours on Indiana Highway No. 64, near Vincennes, Indiana.

A REVIEW OF HIGHWAY PROGRESS

A Paper Presented Jan. 20, 1936 at Annual Convention of American Road Builders' Association, Cleveland, O.

By THOMAS H. MAC DONALD
Chief, U. S. Bureau of Public Roads.

T. H. MacDonald

NOT LONG ago the question was asked if the quality of highway engineering technique and administration is advancing in step with the increase in expenditure of Federal highway funds. Concern was expressed that with the problem of providing employment so acute, and with the consequent pressure to get work under way rapidly to the full extent of available funds, there might be a let-down in standards heretofore existing.

Such a question is a most natural one. There have been previous experiences which justify a doubt. Also, it is a difficult question to answer convincingly because of the magnitude of the sum total of the thousands of individual projects involved. No mere assertion of opinion is important except as it accurately reflects a conclusion that may logically be drawn from the facts. There is another and broader question, that of the direction in which we are going and the indicated implications as to the future.

While those constituting the American Road Builders Association have what may be termed the interest of responsibility, the general public has the interest of user and owner. The consequences of an operation of nation-wide dimensions and of such a personal service character reach far into the future. A road system is not rebuilt annually. To be a sound public business, roads into which public funds have gone must earn more than their annual upkeep. The difference between an asset and a liability is decidedly more than a matter of opinion. Thus it appears important to present in as concise a manner as possible a review of highway progress covering a number of years, to record the facts and to develop the important trends as support for the conclusions reached.

All measurements are relative, and for the purpose of this review where comparisons are made the five-year average, 1925-1929, is taken as the basing period. This average was selected some time ago by the Bureau as the most representative of the highway improvement activity as a whole, prior to the depression.

Miles Completed

As an over-all picture of highway improvement, without distinction as to the degree, or between types, the base period 1925-29 shows an average annual completion of 17,577 miles without Federal participation in the cost and 10,063 with Federal participation, a total of 27,640 miles.

The succeeding 5-year period, 1930-1934, shows an average annual completion of 22,068 miles from State funds without participation in the cost from Federal highway funds administered by the Bureau of Public Roads. The State funds in some states were increased through loans and grants administered by the Public Works Administration and also by support from the Federal Emergency Relief Administration. In addition, there was an average annual completion of 15,514 miles with the whole or a part of the cost met from Federal highway funds administered by the Bureau of Public Roads. Together, these total an average annual completion of 37,582 miles or nearly 10,000 miles per year above the preceding 5-year average. These averages, however, fail to show the major influences which the Public Works appropriation of June, 1933, and succeeding Federal appropriations have had in holding highway building to the high level for this period. For the two years 1933-1934 the average completion mainly through state expenditures dropped to 15,963 miles and for the same period the average mileage completed with the cost in whole or in part from Federal funds administered through the Bureau rose to 20,048 miles. Together, the average for this two-year period is 36,012 miles. Without the record for 1935 and 1936 the conditions are such that it may be predicted the same relative results will inevitably follow for these years.

For the years 1933-1936 inclusive, the Federal appropriations for highways are the major influence in holding the average annual mileage completion at a figure well above the average for the pre-depression base period and very close to the highest 5-year average. (See Table I.)

TABLE I—MILES COMPLETED

	Without Federal Participation	With Federal Participation	Total Built
1925	12,152	11,000	23,152
1926	15,830	10,722	26,552
1927	16,502	10,220	26,722
1928	19,496	9,756	29,252
1929	23,904	8,618	32,522
5-yr. average	17,577	10,063	27,640
1930	24,844	10,433	35,277
1931	28,634	16,000	44,634
1932	24,933	11,038	35,971
1933	14,926	18,545	33,471
1934	17,001	21,552	38,553
5-yr. average	22,068	15,514	37,581

Highway Funds

Essentially the same story is told by a study of highway funds. Divided among the major purposes for which they are used, the following averages show the trends:

For construction by the States:

Average expenditures from state funds:

For the 5-yr. base period..$367,000,000

Federal aid funds.... 82,000,000**

Total annual average.. $449,000,000

For the 5-year period 1930-1934:

State funds $403,000,000*

Federal aid & grants.. 192,000,000**

Total annual average.. $595,000,000

For the 2-year period, 1933-1934:

State funds $234,000,000*

Federal aid & grants.. 257,000,000**

Total annual average. $491,000,000

*May include some Federal grants from the Public Works Administration or Relief Administration.

**Only includes funds administered through Bureau of Public Roads.

In 1934, for the first time since the original Federal-aid act of 1916, the Federal contribution for construction rose well above that of the States. This will also be true undoubtedly for the 2-year average of 1935-1936.

For maintenance, equipment, interest and miscellaneous:

Annual average for the 5-year base period $225,700,000

Annual average for the 5-year period, 1930-1934 258,700,000

In 1934 the expenditures for these purposes were $293,400,000, an amount $34,700,000 higher than the average for the 5-year period and $74,200,000 higher than for the previous year.

For construction, maintenance and miscellaneous expenditures by local governments:

Annual average for the 5-year base period $615,700,000

Annual average for the 5-year period, 1930-1934 528,800,000

Annual average for the 2-year period, 1933-1934 388,000,000

The average annual expenditure by the local governments for the 2-year period 1933-1934 falls below the average for the five years 1930-1934, by $140,800,000 and below the average for the base period 1925-1929, $227,700,000. (For expenditures by years see Table II.)

Surfaced Mileages

During the 5-year base period the net progress on the State highway systems in the construction and reconstruction of surfaced roadways was made up of 42,575 miles of low type and 33,640 miles of high type road surfacings, an average annual net increase of 15,243 miles and a total net increase for the period of 76,215 miles.

For the 5-year period, 1930-1934, corresponding net increases were 45,823 miles of low type construction, 34,841 miles of high type construction, an average annual net increase of 16,133 miles and a total net increase of 80,664 miles.

On the face of these figures, the first five years of the depression produced 4,400 miles net increase in surfaced roadways on the State highways over the production for the preceding five years of prosperity. Actually, the real gain was much larger, in part due to a more accurate classification of types, and in part to a marked advance in the standards of design and construction. (For details by years see Table III.)

TABLE II—STATE AND FEDERAL EXPENDITURES ON STATE SYSTEMS AND FUNDS EXPENDED ON LOCAL ROADS

Year	State funds for—Construction Million	State funds for—Maintenance, equipment, interest, and miscl. Million	Federal Funds Million	Funds Expended Local Roads Million
1925	$297.1	$208.6	$ 92.2	$543.5
1926	277.0	219.8	79.2	587.7
1927	324.1	236.3	80.2	643.4
1928	457.2	221.3	80.8	659.2
1929	479.8	242.5	77.6	644.8
5-yr. average	367.0	225.7	82.0	615.7
1930	620.7	266.9	92.5	700.5
1931	512.9	248.6	218.1	637.2
1932	414.6	265.3	136.9	530.1
1933	266.3	219.2	180.6	413.8
1934	203.2	293.4	334.5	362.3
5-yr. average	403.5	258.7	192.5	528.8

TABLE III.—STATE HIGHWAY SYSTEM MILEAGE EXISTING HIGH AND LOW-TYPE SURFACING

Year	Total surfaced miles	Low-type surfaced miles	High-type surfaced miles
1925	144,854	96,505	48,349
1926	163,059	109,110	53,949
1927	176,566	116,427	60,139
1928	193,138	124,765	68,373
1929	208,324	133,211	75,113
5-year average	177,188	116,003	61,184
1930	226,772	142,659	84,113
1931	242,700	146,359	96,341
1932	260,484	151,782	108,702
1933	271,845	157,995	113,850
1934	288,988	179,034	[1]109,954
5-year average	258,157	155,565	102,592

[1]Drop in high-type mileage due to resurvey of Texas system, as a result of which approximately 6,000 miles previously reported as bituminous macadam were assigned to the lower types.

TABLE IV.—SECONDARY ROADS UNDER STATE CONTROL

Year	Total surfaced miles	Low-type surfaced miles	High-type surfaced miles
1932	5,576	4,543	1,033
1933	38,648	36,440	2,208
1934	57,077	55,166	[1]1,911

[1]Decrease due to miscellaneous adjustments in State records.

Secondary Roads Under State Control

In addition to the increase in the mileages of surfaced roadways on the States highways, there has been a very important advance in the improvement of secondary roads which have been placed under the control of State highway departments in the period 1932-1934.

The total surfaced mileage on secondary roads under State control increased 51,000, the details of which are shown in Table IV.

There is no other new departure from the previously existing general plan of administration of highway affairs that is as likely to make the same rapid progress as the changing of local roads to the control of the State highway departments. The compelling motives are two:

First, to place the cost burden upon the State for the purpose of lowering or doing away with local road taxes, and second, to secure for the secondary roads a larger participation in the gas taxes and motor vehicle license fees, plus the benefits of administration under the State highway departments. This move would undoubtedly be in the direction of efficiency and economy, if the States were provided with the necessary funds. All of the States which up to this time have been required to take over all or a large part of secondary roads have been given the added responsibility without a commensurate increase in support funds. Were it not for the heavy increases in Federal highway funds which must be regarded as temporary, these States would now find themselves in an impossible situation. The inevitable results of continuation of the policy as it has been put into effect will be to stop necessary new construction and reconstruction of the principal State arterial highways. Sane policies of administration should take exactly the opposite direction. The major highways must be continuously brought to the highest serviceability to provide the inducement for a greater traffic use from which increased revenues may be obtained.

TABLE V.—LOCAL ROAD MILEAGE EXISTING

Year	Total surfaced miles	Low-type surfaced miles	High-type surfaced miles
1925	376,406	348,409	27,997
1926	387,005	357,967	29,038
1927	412,155	380,358	31,797
1928	432,999	398,813	34,186
1929	454,111	416,770	37,341
5-year average	412,535	380,463	32,072
1930	467,338	425,742	41,596
1931	587,028	541,614	45,414
1932	595,999	549,767	46,232
1933	642,423	594,403	48,020
1934	*672,254	*628,666	*43,588
5-year average	593,008	548,038	44,970

*7 States estimated.

Secondary Roads Under Local Control

One of the most striking changes is in the accelerated increase in mileages of surfaced secondary or local roads. During the 5-year base period, 1925-1929, surfacings were increased by 99,530 miles low type, and 15,022 miles high type, roadways. For the 5-year period, 1930-1934, there was an increase in surfaced mileage of 211,900 miles low type, and 6,247 high type, road surfaces—a total of 218,000 miles or nearly double the increase in surfaced roadways for the preceding 5-year period. This increase reflects both increased support for local roads from the road user revenues, the gas and motor vehicle taxes, work made possible through loans and grants from the Public Works Administration and large support from the Federal Emergency Relief Administration and the Federal agencies established to provide employment.

During the period that the greatest increase in rural road mileage has taken place, local revenues from local sources, have materially decreased. In this connection see Table V.

Types of Highway Improvements

As an illustration of the build-up of the large highway construction programs and the different types which constitute the program, Table VI is submitted.

This program has been financed for the major part from Federal grants with minor participation by the State, and differs from previous Federal aid programs in that approximately 25 per cent of the funds were used for improvements of secondary roads, 25 per cent for municipal improvements and the remaining 50 per cent

TABLE VI.—U. S. PUBLIC HIGHWAY PROJECTS

(From 1934 Public Works Appropriation $400,000,000 apportioned June 23, 1933)
and
(1935 Hayden-Cartwright $200,000,000 apportionment, June 19, 1934)

Summary by Types of Construction—December 31
(This summary table is accumulative)

Types	1933 Estimated Total Cost (Thousands)	1933 Miles	1934 Estimated Total Cost (Thousands)	1934 Miles	1935 Estimated Total Cost (Thousands)	1935 Miles
Graded and drained	$32,170	4,149.0	$54,503	6,561.5	$59,322	6,969.8
Sand Clay—						
Untreated	2,708	569.9	3,546	975.6	4,289	1,155.5
Treated	4,205	557.7	9,199	1,048.4	10,861	1,199.0
Gravel—						
Untreated	32,646	4,973.5	66,077	9,351.7	80,940	11,121.9
Treated	12,038	1,317.7	13,012	1,291.6	16,540	1,776.3
Macadam—						
Untreated	2,312	203.8	2,148	208.1	2,303	179.4
Treated	3,877	238.5	12,932	867.1	15,275	991.5
Low cost bituminous mix	15,918	1,801.1	29,716	3,232.6	35,801	3,739.7
Bituminous macadam	10,248	461.1	20,407	1,006.5	21,812	1,051.4
Bituminous concrete	22,806	706.0	46,324	1,328.1	56,398	1,655.3
Portland cement concrete	91,418	2,520.9	163,522	4,297.9	190,474	4,947.9
Block	4,509	63.0	9,699	121.9	11,417	140.5
Bridges and Approaches	32,262	72.2 (2431)	69,426	124.9 (5055)	82,730	154.9 (5767)
Grade separations—Railroad-Highway	5,811	12.1 (150)	24,509	39.2 (524)	33,634	51.8 (675)
Grade separations—between highways	704	.5 (9)	2,827	1.4 (49)	3,702	1.9 (69)
Miscellaneous	216	....	2,977	....	7,096	....
Total	273,848	17,647.0	530,824	30,456.5	632,594	35,136.8

Note: The figures in parenthesis indicate the number of structures.

TABLE VII—SUMMARY STATUS HIGHWAY PROGRAM

(From 1934 Public Works Appropriation $400,000,000 apportioned June 23, 1933)
and
(1935 Hayden-Cartwright $200,000,000 apportionment, June 19, 1934)

	Week ending Dec. 29, 1934					
	Contract Only			Force Account Only		
	Estimated Cost (thousands)	Mileage	No. of Proj.	Estimated Cost (thousands)	Mileage	No. of Proj.
Approved	$ 29,135	1,350	585			
Contract awarded	32,374	1,881	697	$ 1,137	88	97
Under construc...	138,124	6,081	2,062	9,685	828	353
Completed	297,607	17,750	6,395	22,762	2,476	939
Total	$497,240	27,062	9,739	$33,584	3,393	1,389
	Week ending Dec. 31, 1935					
Total	$596,463	31,901	12,165	$36,131	3,235	1,713

on the rural Federal aid system. The large mileage of gravel surfacings reflects the improvement of secondary roads.

Distinction Between Contract and Force Account Work

The policy of doing public construction work by force account has frequently agitated those engaged in the contracting business. As an indication of the conduct of the Federal highway work from Federal grants administered by the Bureau the attached Table VII is submitted.

In this schedule the status of the program for the final week of each of the years 1934 and 1935 divided between contracting and force account work is shown.

Force account projects constitute so minor a part of the program as to dispel any real cause for valid criticism from the contracting industry. The fact should be further noted that most of the projects included in the force account program are for secondary road construction where the individual projects are small and hardly suitable for contracting. There has been only one instance where force account has been carried on by the State beyond reasonable limits and this policy has since been abandoned.

Price Trends and Cost

The relative average prices for road construction have been calculated by using a composite mile made up of the different units of work in proportion as these were used in the total program. The composite mile at the prices bid for the 5-year base period, 1925-1929, gave a cost index of $17,026. This index dropped sharply for 1932 to about 60 per cent. It rose in 1933 to an average of 74 per cent. It continued slightly upward in 1934 and for 1935 leveled off at approximately 80 per cent. We would therefore at this time be paying approximately 80 per cent of the cost for the pre-depression period if it were not for the factor of changes in design. The changes and adaptation of modern highway designs to present day needs are discussed in another paper by Mr. R. E. Toms, Chief, Division of Design, Bureau of Public Roads, and will not be touched upon here except insofar as they affect cost.

There has been a gradual increase in the number of units of construction used through the design changes to provide better and safer highways, so that compared with the average number of units used for the base period the index now stands as an average at slightly above 140 per cent. That is, about 42 per cent more units are being used per mile of standard highway construction than for the base period.

Since the price index stands at approximately 80 per cent the cost of the very much better designed and constructed highways has only increased to approximately 114 per cent.

On the basis of this showing as to prices and costs, therefore, while so serious a need exists for the providing of employment and for the construction and reconstruction of highways, it is a sound public policy to give maximum employment upon the highways so long as this can be done within the reasonable costs now prevailing.

The Program for the Immediate Future

The opportunity is now presented for one of the largest annual construction programs we have ever had. A summary of the Federal appropriations available to the States for construction during 1936 amounts to a total of $579,291,000, divided approximately as follows:

This summary is made up of balances of the Federal highway grants and the regular Federal aid funds for 1936, plus State funds which have been programmed.

1. Going contracts $152,344,000
2. Plans approved, ready for contract. 113,884,000
3. Funds available for new projects.. 333,300,000

Total $599,528,000

On the above showing it is apparent that the greatest activity and the highest cooperation must prevail among all agencies in order to get this very large program under way and push it vigorously for the purpose of providing the largest amount of employment possible and of demonstrating the possibility of sound highway construction as an employment measure.

While there has been some tendency to find fault with the rules and regulations governing highway improvement, it must be taken into consideration that the reason these funds have been provided in such large amounts is for the purpose of furnishing employment, and the regulations have been established to secure this objective. A discussion as to the amounts of labor provided by highway construction is provided in a paper prepared for this meeting by Mr. T. Warren Allen, Chief, Division of Management, Bureau of Public Roads, so will not be touched upon further here. It is important, however, that if the highway industry is to fulfill the purposes for which these funds were supplied, the program must be put under way more rapidly than it has been in previous months and labor must be given employment in rapidly increasing numbers.

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Traffic Development in Ohio 1925-1935

Mr. H. S. Perry, Assistant Chief Engineer, Bureau of Maintenance, Ohio State Highway Department, in a paper presented at the 1936 convention of the American Road Builders' Association, gave the following interesting statements regarding traffic:

"The percentage development in average daily density of truck traffic in Ohio in the ten-year period between 1925 and 1935 is 147. The average truck weight (manufacturer's rating) during 1925 was approximately 2½ tons; that during 1934 was practically double, owing to the development of three-axle equipment. An axle loading of 15,000 to 18,000 pounds is quite common. Over the same period passenger traffic has increased only 86 per cent, accompanied by a decrease in average concentration, rather than an increase. One has but to take an occasional night trip over most any of our highways to be impressed with the ever-increasing development of commercial and industrial hauling."

Improvement of 8-Mile Section of River Road (Route 133) in Southern Indiana

Left: 8-Mile Section of Route 133 Near New Albany, Ind., Being Widened from 4 to 6 Ft. by 6 In. Thickness 2-3½ In. Stone. The Old Road Was of Bituminous Surface-Treated Type 14 to 16 Ft. Wide. Center: Pressure Distributor Applying Asphalt (85 to 100 Penetration) at the Rate of 1 Gal. per Square Yard to Widened Portion of Old Road. Right: View of the Widened Area of Road After Application of Asphalt

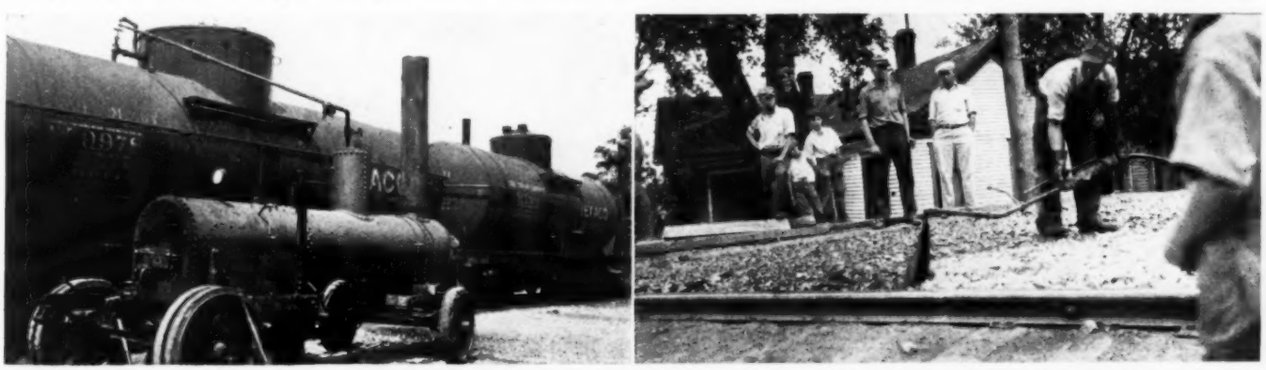
PROGRESSIVE RURAL ROAD IMPROVEMENT IN INDIANA

By A. J. MOYNIHAN

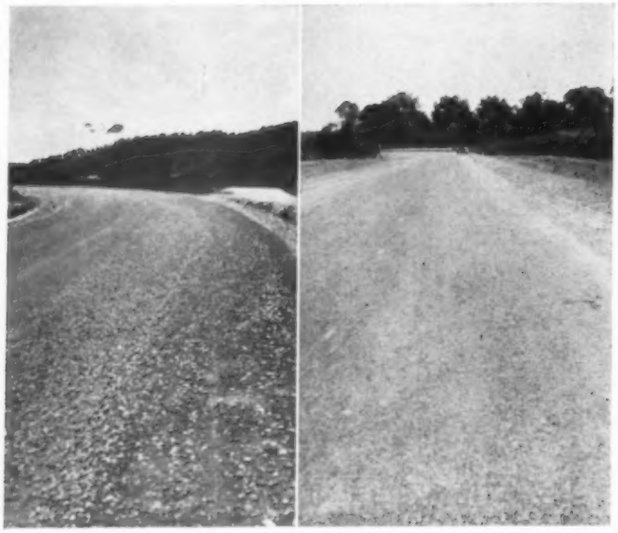
THE Indiana State Highway Department takes over several hundred miles of rural roads annually. The roads, in the main, require considerable re-location to secure better alignment, and to eliminate sharp curves and dangerous railroad crossings. The objective of the state highway department engineers is to convert these roadways into smooth highways providing clear vision so as to avoid all possible driving hazards. In orderly sequence, the following operations call for attention:

Agreements as to right-of-way must be reached; new grades must be established; the road widened and drainage structures built. In many cases new berms and ditches are necessary. So far as possible the investment in the old roadway must be salvaged. To arrive at the finished roadway, the engineers of the state highway department are called upon to plan their projects to be completed as rapidly as funds become available.

In some cases, a specific project can be entirely completed under one contract, which includes all phases of construction and provides for materials required to



Left: Tank Car of Asphalt Being Heated Prior to Unloading. Right: Applying the Hot Asphalt by Hand-Spray Over Newly Laid Stone at Railroad Crossing



Left: Photograph Taken After Widened Roadway Had Received Prime Coat of ¼ Gal. Cutback Asphalt Over Which Was Distributed 25 Lb. of Gravel per Square Yard. Gravel and Asphalt Were Turned Over and Allowed to Stand Approximately 10 Days. Right: Completed Road After Two Additional Applications of Cutback Asphalt Totaling 9/10 Gal. per Square Yard Had Been Applied, Together With Sufficient Aggregate to Bring Total to 100 Lb. per Square Yard. Aggregate and Asphalt Were Thoroughly Bladed and Rolled

turn over to the motoring public a durable non-skid wearing surface. However, in many cases, it is necessary to use progressive road planning. Under progressive road planning, three distinct contracts are let over a period of time for three phases of construction; (1) Construction of grade and drainage structures, (2) Traffic-bound stone or gravel surfacing, followed by (3) Treatment with bituminous materials and aggregates. In this way, the highway department secures in a very few years a greatly increased year-round road mileage at an economical construction cost.

Bituminous types of road construction today are a fundamental in the Indiana Highway Department's construction program, providing suitable surfaces for years of durable service on both primary and secondary road systems. Credit is due the designing and road engineers, the testing engineers, and the chemists of the Indiana Highway Department for bringing roads already incorporated in the system, as well as those taken over annually, to a state of year-round serviceability.

Roads to be approved under the progressive plan can, as they are subjected to greater traffic, be built up by the addition of aggregates securely bound by proper bituminous binders. This can be done either by the road-mix method, or by coating the aggregate prior to construction, through mixing at a central plant, and then spreading to a uniform depth over the existing roadway.

Indiana at the present time has an extensive mileage of smooth comfortable-riding, no-skid bituminous surfaces, which are result of years of research on materials and methods by engineers of the Highway Department. Exacting tests by the testing and chemical engineers of the Highway Department, together with rigid supervision under field inspectors, assure the contractors of selective and quality materials and give the taxpayer smooth, uniformly finished surfaces. Many old roadways have been progressively planned and completed, giving the state of Indiana increased transportation mileage at a moderate cost.

Centralization, Decentralization, and Road Payment Policies

The following is from a paper, "The Works Progress Administration and Farm-to-Market Roads," presented at the 1936 A. R. B. A. convention by Mr. Perry A. Fellows, Assistant Chief Engineer, Works Progress Administration:

"The decentralization of interest in roads would tend to bring about a greater emphasis on rural roads because they are usually short and of more local interest. The centralization of authority for planning roads and the centralization of control over the funds for road improvement would both tend to develop the emphasis on the long distance roads and divert attention from the rural road. Offsetting the increased local interest that is obtained by decentralization is the strengthening of the retarding influence that grows out of increased taxes. If the abutting property has to pay on the spot for an improvement to a local road, then that improvement is very likely to be deferred because the payment for the improvement is more keenly felt. This is particularly true when the burden of the improvement is felt long in advance of the benefit. If the improvement is of a permanent character and the cost could be capitalized and only the current carrying charges or possibly not even all of these could be placed on the abutting property, then the improvement would be more likely to be endorsed by local people. The local people would not often agree to the building of the nearby strip of highway if they felt that they were the ones to bear the whole burden of cost."

▼

Concrete Slabs Without Dowels

Mr. Otto S. Hess, Engineer-Manager, Kent County Road Commission, with headquarters at Grand Rapids, Michigan, gave the following in a paper on pavement design and construction at the 1936 A. R. B. A. convention:

"I should like to mention a slab design which has been used successfully by the writer in Kent County, Michigan, for the past nine years. This slab is constructed as a single unit fifty feet long with the thickened edge all the way around the slab; fabric reinforcement is used throughout. A ¾-inch premolded asphalt expansion joint is used at the end of each slab and the slabs are not connected by dowels or other means for transferring loads at the joints. The loads are taken care of by the thickened edge at the joint. Our pavements have remained smooth throughout the years and are almost a hundred per cent free from accidental cracks. The thickness of the slab is of course varied to suit traffic and sub-grade conditions. Our experience would not indicate that connections at the expansion joints are necessary in order to prevent roughness at the joints. Also, we have never had an instance of a transverse accidental crack at the point where the slab thins down to normal thickness. Possibly this would be the case if the slabs were made considerably longer than fifty feet. It is worthy of note that there are no joints or cracks which the design of the slab has not provided for and this is not true of any other designs in common use today. This type of slab is only being mentioned because of its success over a period of years and because of the fact that it is not being used in any other places known to the writer. As to the choice of design for a particular locality, a pretty good rule to follow is this: If your design embodies the main features of present day practice and is giving you excellent results, stick to it."

INTERNAL-COMBUSTION-ENGINE POWER in the HIGHWAY INDUSTRY

By GORDON C. OLSON

Formerly Editor of MOTIVE POWER

Typical sand and gravel plant with diverse equipment showing particularly a 100-hp. Diesel unit operating sand and gravel pump

IN HIGHWAY construction and maintenance operations there are employed various types of internal-combustion engines ranging in size from the small fractional-horsepower unit to those of several hundred horsepower. The author has endeavored to trace the development of power units and their application in this industry and present a discussion, profusely illustrated, of present practice in engine design.

In PART I, the early highway industry in general was viewed; some elementary ideas of an engine given; and the rise and application of portable steam plants in this industry outlined.

The discussion of heavy-duty gasoline engines, PART II, included: (1) a historical review; (2) a definition of engine horsepower and torque with typical performance curves; (3) a classification of the power requirements of highway machinery and the entry of gasoline engine power; (4) an outline of carburetion and fuel development; and (5) some general improvements in design.

In turning to the small air-cooled gasoline engines that find such diversified application in this industry, PART III, the air cooling problem and its solution was the chief concern, with mention of historical factors and construction peculiarities.

The extended discussion of high-speed Diesel and oil engines, PART IV, is justified by the editorial interest, the rapid development, and the extended use being made of oil-burning engines. The portion of this section presented in the January issue included: (1) a discussion of the Diesel cycle of operation contrasted with the gasoline-engine cycle and the reason for the increased efficiency of the former; (2) a brief history of the Diesel engine and its application to the power needs of this industry, with a mention of its more desirable torque characteristics; (3) fuels for Diesel engines, their development with respect to ignition quality and methods of rating; (4) fuel supply systems and their elements; (5) the fuel-injection pump and the operation of a common type; and (6) the fuel-injection nozzle.

The author and publishers again join in expression of appreciation to the many individuals and manufacturers whose contributions have aided materially in the preparation of this article.

THE HIGH-SPEED DIESEL--AND OTHER OIL ENGINES

Diesel Combustion Chambers—Hesselman Engines—Starting Methods—Economics

SINCE the Diesel engine compresses air only into the combustion space and since a thorough mixing of the fuel particles with the air must take place in an immeasurably short time for efficient combustion, the engineer is confronted with a profound problem in designing the injection system. Different designers have emphasized different parts of the injection system and depended mainly on a particular function for efficient combustion. Several systems have evolved which may be grouped as far as their combustion chambers are concerned. No attempt will be made to discuss the advantages and disadvantages of the various systems as the author does not feel himself qualified to do so. But as one comes in contact with engineers and designers he is made aware that each type of combustion chamber in general practice has its advantages but also its limitations.

This problem of the proper distribution of the fuel in the air charge may be outlined according to the feature most employed. A precombustion chamber may be relied upon for distribution; or, the shape of the combustion space may be such as to create violent turbulence of the air past the fuel jet; or, a more or less plain cylindrical chamber may be used and dependence placed mainly on the fuel nozzle to break up the fuel and distribute it; or, compressed-air injection of the fuel may be used.

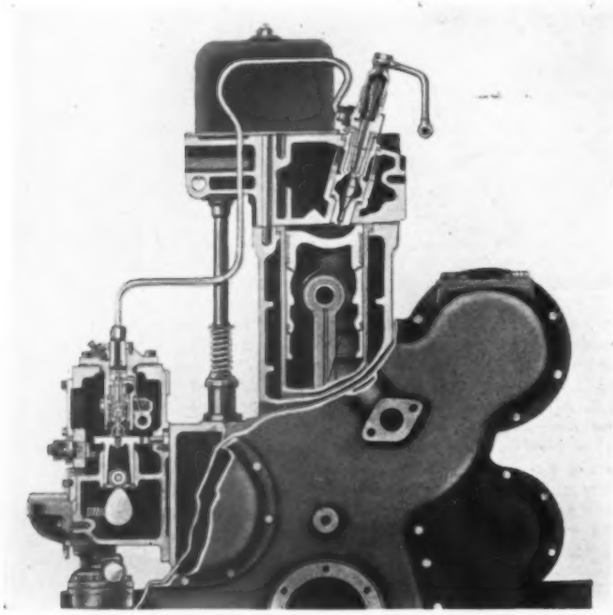


Fig 27—Cutaway view of the Caterpillar precombustion-chamber type injection system showing the pump, single-hole nozzle, precombustion chamber, and main combustion chamber.

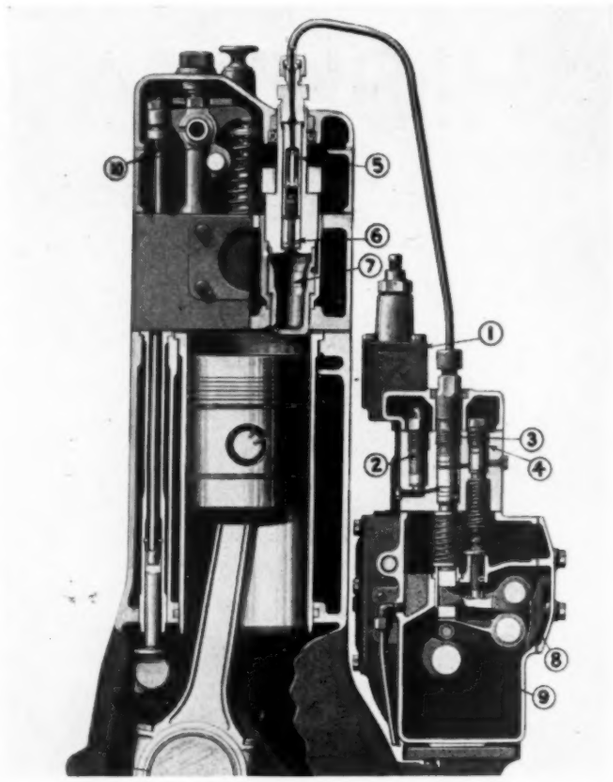


Fig. 28—The International Harvester Company's tractor Diesel showing the injection pump and nozzle construction and the precombustion chamber

Since air-injection fuel systems are not found in high-speed engines, they will not be mentioned except to state that the original and early Diesels employed it and it is still found on the large stationary engines. The distribution is very good but the chief disadvantage is the needed air compressor of very high quality which is not only an added expense but consumes a considerable portion of the engine's power. Many combustion-chamber shapes are so arranged to imitate the air-injection advantages and really function similarly.

Those Engines Employing the Precombustion-Chamber Principle

Two variations of this type of injection system may be observed from Figs. 27 and 28. The clearance volume is divided into a precombustion-chamber volume of from 15 to 30 per cent and the remainder in the main combustion space. This makes it impossible under full load for complete combustion of the fuel to take place within the small space due to the lack of air. The spray nozzle of the single-hole type is located in the

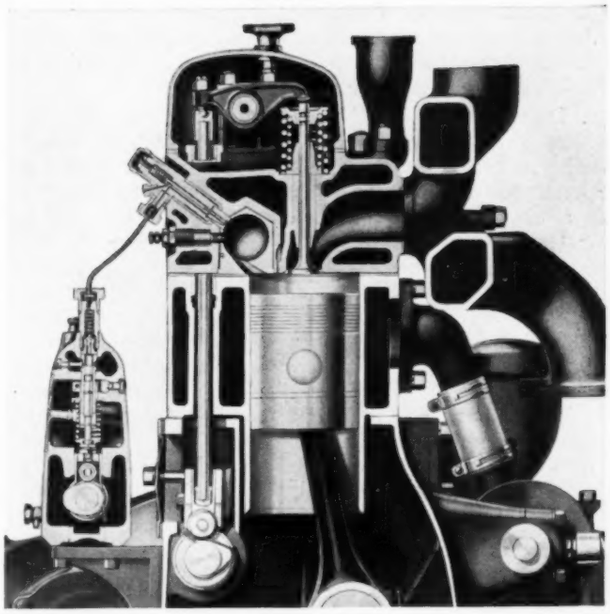


Fig. 29—Section through the Waukesha Comet Diesel showing the spherical-shape combustion chamber of the turbulence type, being an uncooled metal insert in the head. Note also the glow plug to aid starting.

precombustion chamber and is of the hydraulic type. The small chamber is in communication with the main chamber only through a small restricted opening and is constructed in the form of a nozzle piece or a cup of high-grade material. It is desirable that the chamber should be at a high temperature and it is therefore only partially cooled. During the compression stroke the air is forced into the chamber through the restricted passage and is in a state of turbulence at the end of the stroke when the fuel is injected. The spray is ignited immediately by the air in the chamber which has been heated to some 1100 or 1200 deg. F. The partial combustion in the small chamber causes a rapid rise in pressure which forces the burning fuel into the large combustion space through the orifice causing great turbulence and thorough mixture of the partially burned gases with the remainder of the air and consequently complete combustion. It is apparent that this action resembles closely the idea of air-blast injection employed on air-injection engines.

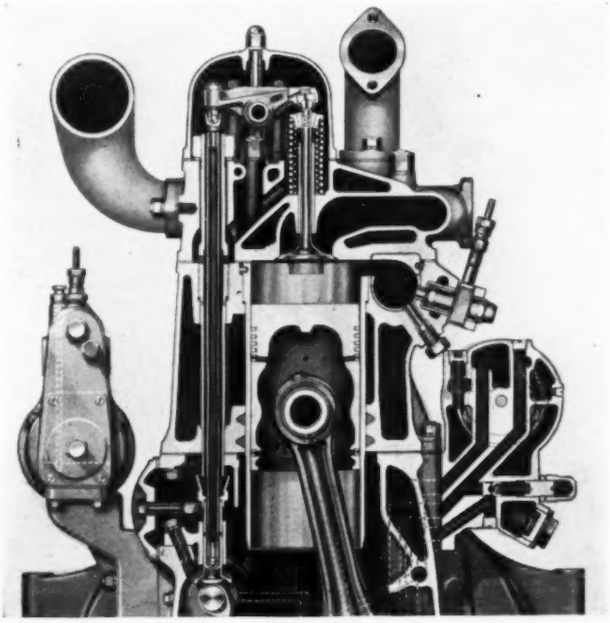


Fig. 30—Front cross-section view of the Hercules Diesel showing the spherical, turbulence-type combustion chamber which is inserted into the block. The piston at the top of its stroke closes off most of the passageway between the turbulence chamber and the cylinder giving an increased turbulent effect.

Those Diesel Engines Depending Mainly on Air Turbulence

Various shapes of turbulence chambers have been constructed, the idea being to mix the fuel with the air through the turbulence of the air and not particularly by fuel spray. The single-hole nozzle is employed injecting into the spherical combustion chambers of the engines illustrated in Figs. 29, 30 and 31, and 32. The distinction between the precombustion-chamber type

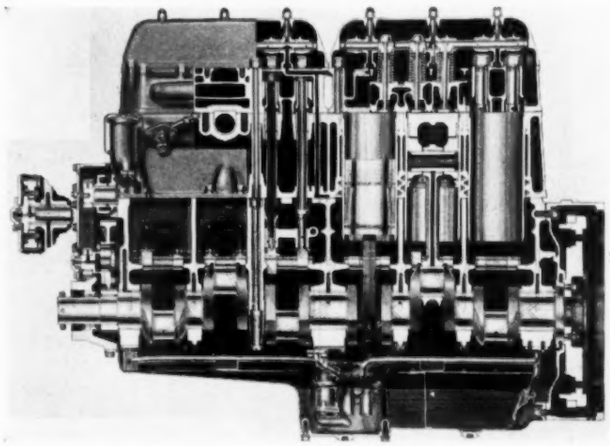


Fig. 31—Longitudinal cross section of the Hercules engine showing the lubricating system and general construction.

just described and the turbulence type is in the shape and especially in the volume of the chamber and the size of the communicating passageway. Usually the volume of the turbulence chamber is made as large a percentage of the clearance volume as is practical, leaving a sufficient clearance between the top of the piston at the top of its stroke and the cylinder head and valves, and is about 80 per cent of the clearance volume. It is desired that all the fuel should burn in the turbulence chamber while this is not the purpose of the precombustion chamber. The passageway is much larger in the turbulence-chamber types as may be observed. The air rushes through the opening as compression proceeds and forms a great turbulence past the nozzle tip. At the top of the stroke with nearly all of the air in the chamber and in a state of great tangential swirl, injection occurs and is broken up and distributed. Combustion proceeds as injection continues, the burning of the fuel possibly following the air. Expansion follows, combustion being nearly complete before the piston descends.

In the engine of Fig. 29 the combustion chamber is a separate insert held in the cylinder head and surrounded by an insulating air space, thus the chamber retains much of the heat and heats the incoming air charge. In the engine of Figs. 30 and 31 the spherical

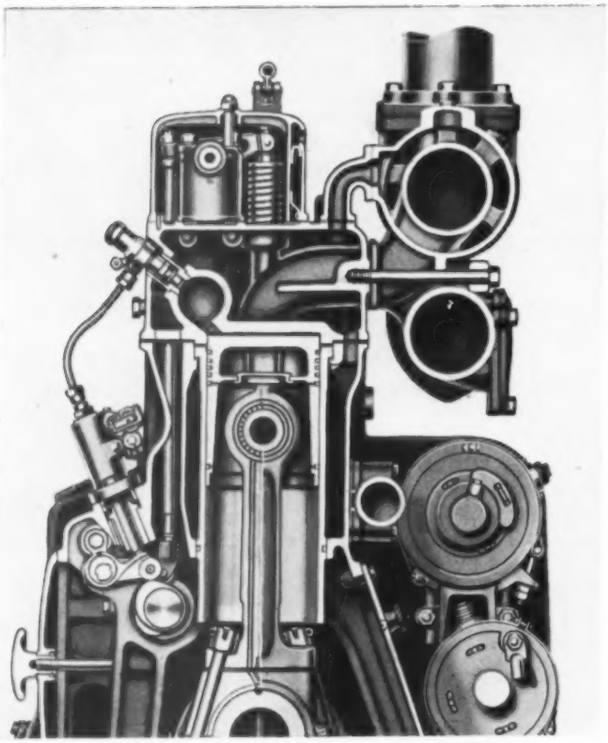


Fig. 32—The Fairbanks-Morse Diesel showing the unit-type fuel pump (one per cylinder), located directly below each nozzle, which injects into a turbulence chamber of spherical shape cast into the head.

combustion chamber is an insert in the block. When the piston compresses the air, turbulence is as described and is accelerated by the gradual reduction of the communicating passageway by the top of the piston which nearly cuts off the throat area at the top of its stroke. This enables the use of a larger passageway. The engine

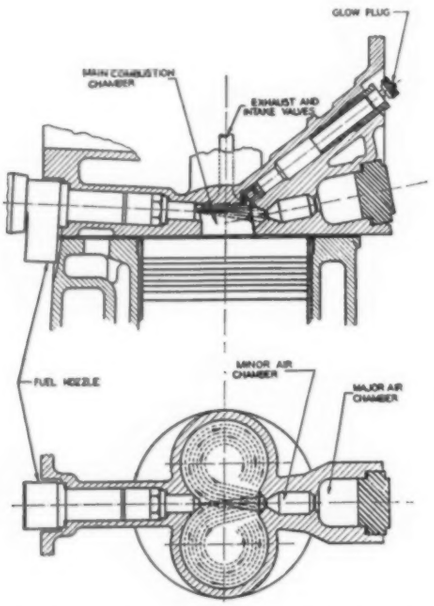


Fig. 33—Sectional drawing of the Buda-Lanova air-cell type combustion chamber showing the main combustion chamber, the nozzle, the air cells, the method of injection and the turbulence

of Fig. 32 employs a spherical chamber cast integral with the head and uses individual unit injection pumps mounted along the crankcase directly under the nozzles and driven from the camshaft.

A Diesel engine employing an air-chamber principle is illustrated in Figs. 33 and 34. From the cross-sectional view of the combustion chamber, the particular construction will be noted. Directly opposite the injector nozzle, which is of the single-orifice type, is placed a major and minor air chamber. On either side of the center line between these two is constructed a figure "8" type combustion chamber with the lobes a little larger in diameter than the valves. The idea of such an air chamber is to approach the air-injection advantages without the air compressor disadvantage. In 1923 it was first considered and the first patents defined the air chamber as an additional combustion space. This design is developed on the theory that a certain amount of fuel should enter the air chamber in order that it in turn may function as an air blast (when combustion of the portion of the fuel injected is ignited) materially aiding combustion of the remainder of the fuel which is injected and burned in the main combustion chamber. The action is as follows: As the piston compresses the air, a portion of it passes into the air chambers so they are filled with air under pressure. The first portion of the fuel is injected through the heated combustion space into the orifice of venturi form of the air chamber.

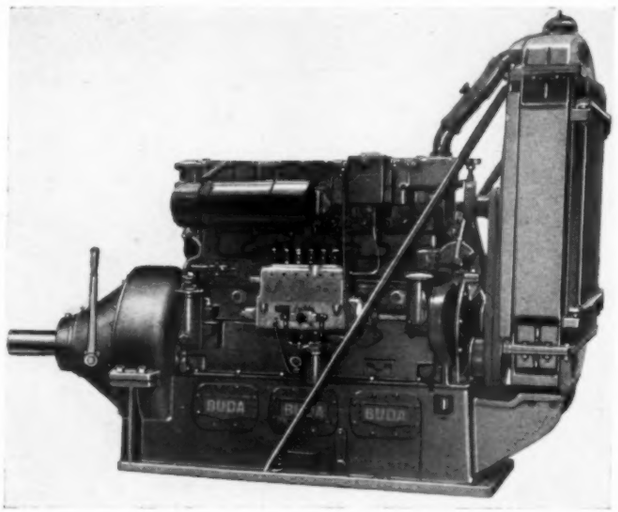
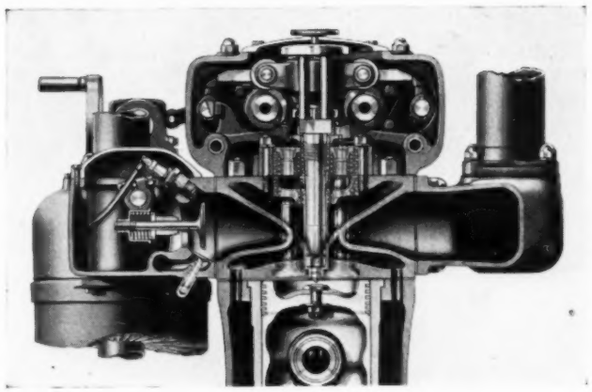


Fig. 34—A Buda-Lanova 6-cylinder industrial power unit with clutch.

Violent combustion takes place therein which increases rapidly in pressure causing the air and partially-burned fuel to reverse and issue forth from the orifice in the face of the fuel jet of the residual spray causing violent turbulence or swirling motion in the main combustion chamber on each side of the jet. It is intended that the locus of ignition should take place in the main combustion chamber.

Those Diesel Engines Depending Mainly on Injection Sprays

The emphasis in this type of combustion chamber is placed mainly on the injection system and the combustion chamber is usually formed to accommodate the multiple-hole spray nozzles generally used. From Figs. 35 and 37, it will appear that the piston head commonly forms the combustion chamber. The engine of Fig. 35



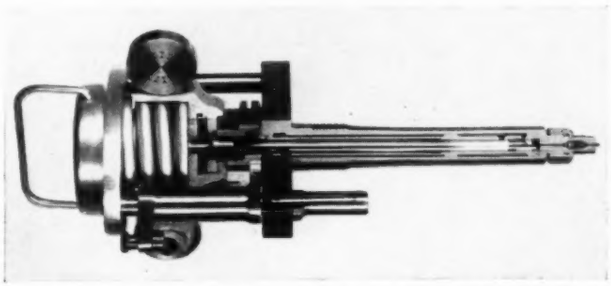
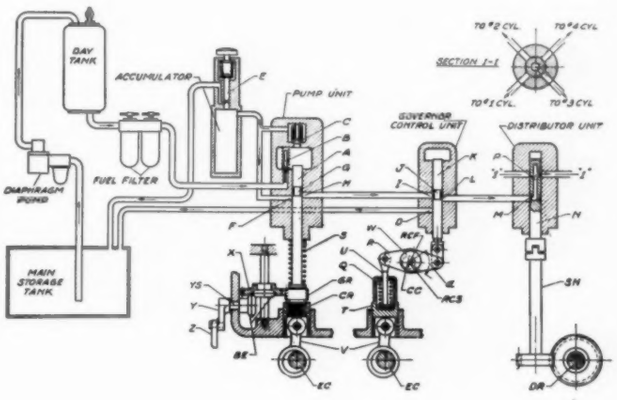


Fig. 35.—(*Above*) *Cutaway view through the combustion chamber* (*open type*) *and manifolding of the Murphy Diesel engine showing the combination fuel pump and injector nozzle unit, the overhead camshafts operating the pumps and valves; and the gasoline starting system.* (*Below*) *Cutaway view of the pump and nozzle unit which is easily removed and interchangeable between cylinders*

employs an innovation of interest. The nozzle tip will be seen to be located in the center of the combustion space and is constructed as an integral part of the fuel-injection pump, Fig 35 (below). Near the nozzle tip is the fuel pump which operates similarly to the one already described, obtaining variation in amount injected by rotation of the plunger. This is accomplished by a gear and sector arrangement connected to a lever which in turn is connected to the governor rod. The unit is placed in an inverted position as shown and is operated by one roller on each side which match two synchronized camshafts turning in opposite directions. A large coil spring tends to hold the plunger at the bottom of its stroke and is used to discharge the fuel instead of direct cam action. During the intake and compression strokes of the piston, the cams hold the plunger in its up position and the barrel is filled with fuel. With the piston at the top of its compression stroke, as in Fig. 35, the cams begin to permit the coil spring to lower the plunger which injects fuel finely atomized, through the multiple-hole nozzle into the combustion space, the amount being determined by variable cutoff. After injection further rotation of the cams return the plunger to its upper position. Two inlet and two exhaust valves operated from the overhead camshafts are used in this design, two of which are shown in phantom. The piston is protected from the heat of combustion by a cup-shaped, stainless-steel piston head bolted to the top of the piston. The gasoline starting system will be mentioned later.

A direct-injection Diesel engine is illustrated in Fig. 36 which employs a special fuel system, a variation of what is called the common-rail injection system. In the systems thus far described, the fuel is injected directly from the pump cylinder through an automatic nozzle, in which systems one pump is required for each cylinder. In the common-rail system, a single fuel pump forces the fuel into a common reservoir where it is maintained under the injection pressure. Each nozzle, in the common design, is in connection with this reservoir through high-pressure piping and also contains fuel under constant pressure. The nozzles are held closed by springs and are opened mechanically at the proper instant and held open for the desired period of injection. In the diagrammatic sketch of Fig. 36 is illustrated a system which employs a fuel distributor and metering unit and automatic nozzles in place of the mechanically-operated ones. The fuel pump of constant stroke receives the fuel from the tank through the filter from the diaphragm pump and supplies it under high pressure to the accumulator where it is maintained at constant pressure by relief valve *E*. This fuel under injection pressure needs to be conducted to the proper cylinder at the right instant and in proper amounts, or for a certain time interval. This is done by having two control valves and one distributor unit. A lower portion of the pump plunger *A* is made to serve as the control valve *G* governing the beginning of injection in any cylinder, the governor control unit and valve *J* controls the end of injection, while the distributor unit *N* conducts the fuel to the proper cylinder. In the sketch the units are shown in position for beginning of



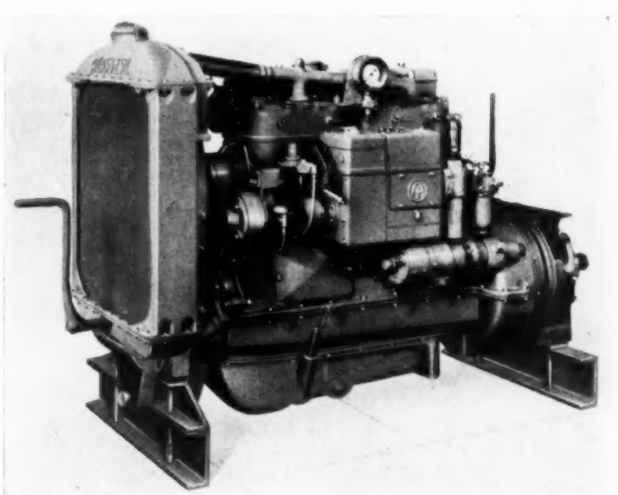


Fig. 36.—*The Atlas Imperial* 4-*cylinder industrial Diesel power unit and a sketch showing the component parts of the fuel system*

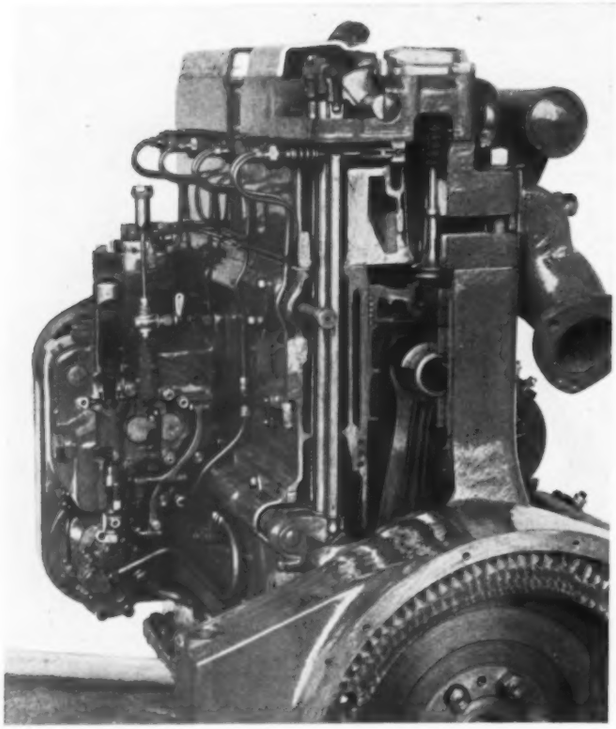


Fig. 37—A Cummins engine with cylinder cutaway to show the combustion chamber with small air cell in the piston head and the injector mounted in the center and operated by a push rod.

injection. The distributor *P* has placed the line from the accumulator in communication with cylinder No. 1 and the valve *J* is in its upper position letting the line open through it, but valve *G* is still closed obstructing the flow of fuel. Since this plunger is moving downward, it will in an instant place ports *F* and *H* in communication and injection will begin. Plunger *K* is also moving down and will soon close off port *I* from *L*, when injection will cease. As it moves further down, an instant later port *L* will be placed in connection with *D* (leading to the fuel tank) causing the pressure in the line from the distributor to the nozzle to collapse giving the instant termination of injection desired to prevent dribbling from the nozzle. Both of the valves are operated by shaft *EC* which runs at twice engine speed on a 4-cylinder engine, thus making a cycle for each power impulse, while the distributor shaft *SN* runs at one-half engine speed and has the four outlets. Governing is by means of rotating the eccentric *W* which raises and

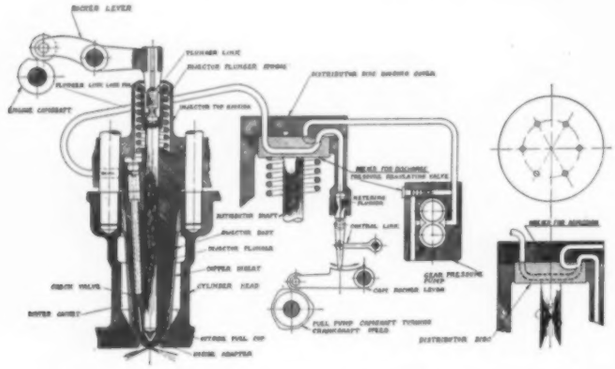


Fig. 38—Sketch of the Cummins fuel-injection system showing its component parts.

lowers the fulcrum (*RCF*) of the lever *R* giving a later and earlier fuel cutoff, respectively. As it is turned in a clockwise direction the cutoff will become earlier or the amount of fuel injected less until at the bottom of its angle port *I* will have closed before port *F* of the pump unit opens and no injection will occur. Means are also provided for varying the beginning of injection with the engine speed.

Another Diesel engine employing a semi-quiescent combustion chamber and a special type fuel system with mechanically-operated injectors is shown in Fig. 37. It will be noticed that three push rods are used per cylinder—two for the valves and one for the injector which receives a constant stroke at constant intervals. Also that a small air cell is constructed into the top of the piston and has but a small hole at the top directly beneath the injector tip. The injection system comprises a single gear pump for supplying the fuel from the tank under a pressure of about 100 lbs. per sq. in., to the single fuel or metering pump which is placed in contact with the various injectors by a distributor shaft with suitable indexes (Fig. 38). The varying amount of fuel is governed by the variable stroke arrangement of the metering pump which supplies an equal charge at low pressure to each injector. Upon its suction stroke it receives a barrel filled with fuel from the gear pump by means of the distributor disk which indexes for admission as shown at the right. When the metering plunger is forced upward by the cam and linkage it is placed in contact with the proper injector by the dis-

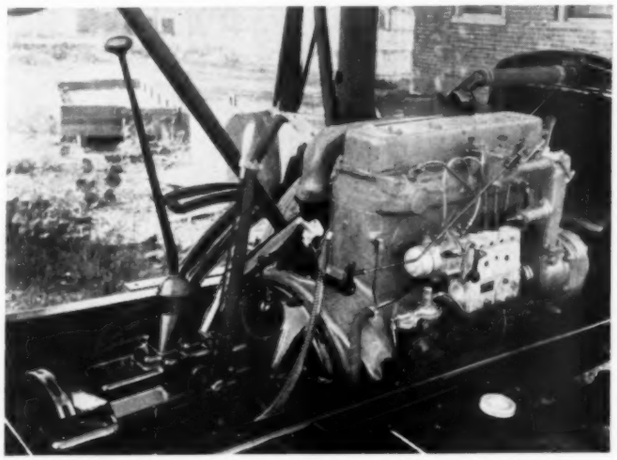


Fig. 39—Hesselman engine mounted in truck chassis showing accelerator control and governor mechanism.

tributor disk delivering its charge into the injector cavity on the intake stroke of the cylinder piston. The injector plunger, being raised during the latter part of the intake stroke and having received the proper amount of fuel, is still being gradually retracted during the early part of the compression stroke, thus preventing the fuel from leaking into the combustion space. During compression a tiny portion of the hot compressed air forces its way through the small nozzle holes into the injector cavity having a cracking and gasifying effect upon the fuel to be injected. At the end of the compression stroke, the injector plunger is suddenly depressed, raising the pressure and injecting the charge through the multiple-hole nozzle (which finely atomizes it) into the combustion chamber. As the piston goes down, the higher pressure in the air cell forces a blast of air against the nozzle tip freeing it of any

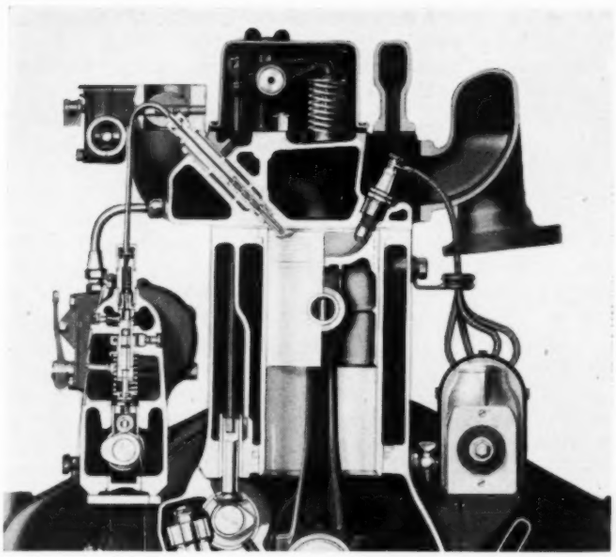


Fig. 40—End section of the Waukesha-Hesselman engine showing Bosch fuel pump and special open-type nozzle with two spray holes, cavity piston, magneto, and spark plug.

carbon formation and aiding combustion by a turbulence effect. The plunger remains seated during the exhaust stroke and the cycle is repeated.

Hesselman Type Oil Engines

Supplementary to the Diesel engine is the Hesselman oil engine which burns the same fuels as the Diesel but is a low-compression engine (similar to the gasoline engine in this respect) employing the injection of the fuel as in the Diesel but with spark ignition. Its four strokes are pictured in Fig. 41. The combustion chamber is formed in the piston head with the injector and spark plug entering diagonally, as noticed in Figs. 40 and 43. During the intake stroke, air fills the cylinder, as in the Diesel, but is compressed only to about 125 lbs. per sq. in., which is not high enough for compression-ignition. Near the end of compression, the fuel is sprayed into the chamber through an open-type nozzle and is given an instant to become mixed with the air, when it is ignited by spark, giving the power stroke, when the cylinder is exhausted in the conventional manner.

The engine was first developed and derives its name from one of Europe's foremost Diesel engineers, K. J. E. Hesselman of Stockholm, Sweden. He sought to procure as many of the Diesel advantages as possible without the disadvantage of high compression and its attendant high cost of engine construction. Since the compression is only slightly higher than a gasoline engine, the standard general weight of engine structure is used. The fuel pump and injectors replace the carburetor, and with the exception of design features, are like the Diesel parts. Its performance curves were presented in Fig. 4 alongside the Diesel and gasoline engines of the same size and characteristics. Its performance is not very much different from the gasoline engine as far as fuel consumption by weight and horsepower are concerned but it has a more desirable torque curve at low speeds than the gasoline engine, but not so good as the Diesel.

A factor that must be considered is to arrange a mechanism to furnish at all loads an explosive mixture in the cylinder. This duty is performed by the carburetor in the gasoline engine. By viewing Figs. 39 and 42, it will be seen that the manual control and governor operate merely a butterfly valve in the air intake passage and the rest is automatic. A vacuum cylinder with a spring-loaded piston is in communication with the air intake manifold and operates the rack of the fuel pump by direct connection. As the butterfly valve is partially closed as shown, there will be created an immediate vacuum in the manifold which acts on the control piston, drawing it to the right, giving less fuel injection or vice versa. Standard Hesselman engines will operate on a wide variety of fuels as shown in the chart of Fig. 21. The Hesselman engine is started by a special primer in the intake manifold, which injects gasoline into the manifold, filling the cylinders, and is ignited by the spark plug.

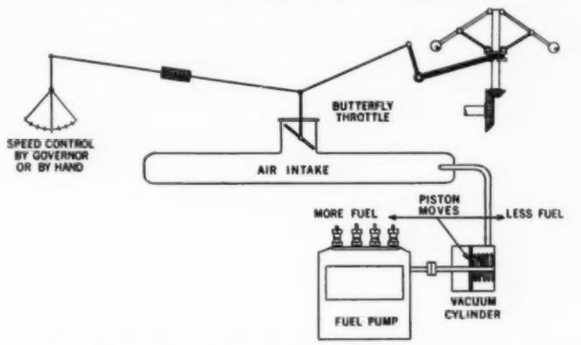


Fig. 42—Diagram showing the throttle and governor connections of the Hesselman engine.

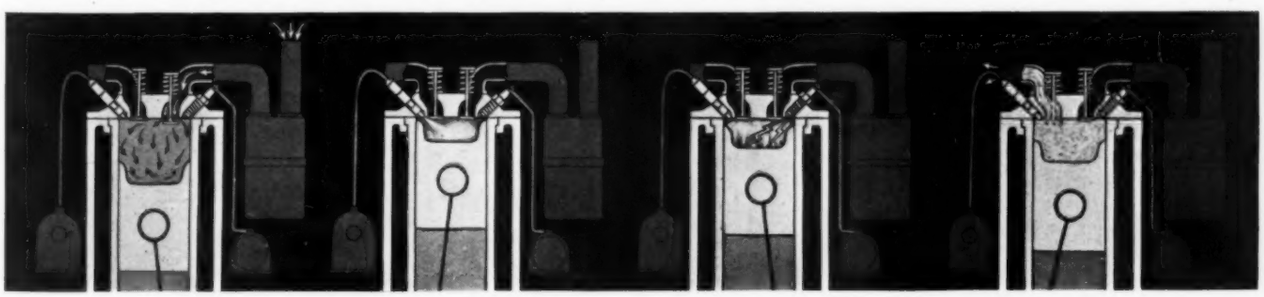


Fig. 41—Diagrammatic sketches showing the various phases of the Hesselman cycle employing fuel injection with spark ignition. The piston on the intake stroke draws in air only as in the Diesel cycle but is comparative to the gasoline engine in compression pressure. Fuel is injected near the end of compression and is ignited by spark plug giving the power stroke. The exhaust stroke is similar to the gasoline engine.

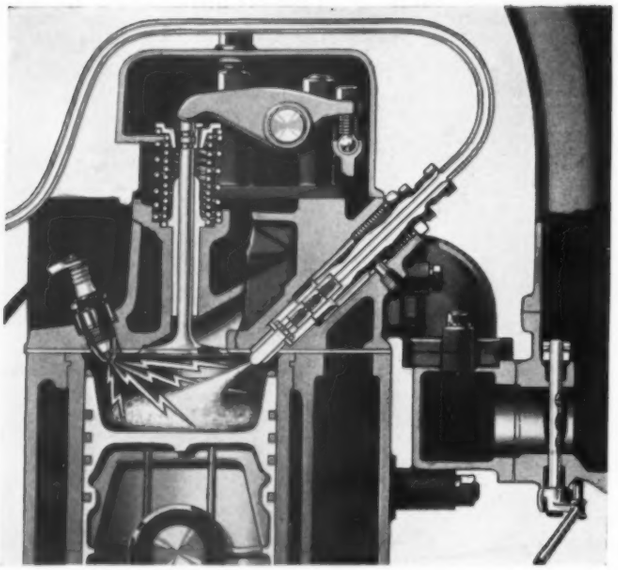


Fig. 43—Section through the Allis-Chalmers tractor oil engine employing fuel injection with spark ignition.

Starting Systems for Diesel Engines

The Diesel engine because of its high compression pressures and compression-ignition features presents a much more difficult starting problem than the gasoline engine. Starting systems of the various engines described may be divided into (1) an auxiliary gasoline engine, (2) gasoline starting incorporated directly into the design, and (3) electrical means. The engine close-up view of Fig. 44 shows a 2-cylinder gasoline engine mounted on the Diesel and connected by clutch to the flywheel. The gasoline engine, having been started and its exhaust having been used to slightly heat the Diesel manifolding, is engaged to turn over the Diesel, whose compression has been released. When running at sufficient speed, the compression is restored and the injection system operated to start the Diesel when the starting engine is released.

In the engine of Fig. 45, an arrangement has been made to start the Diesel and operate it for several hundred revolutions as a gasoline engine. This requires a duplex intake manifold; carburetor; magneto; an auxiliary combustion chamber, with a spark plug, arranged to be placed in communication with the main combustion space; and a suitable linkage to control the whole. An auxiliary valve is placed in the cylinder head which when open as shown connects the added volume containing the spark plug to the combustion chamber. This gives a low enough compression ratio for gasoline operation. A single lever opens this valve in each cylinder; turns the double butterfly valve in the intake manifold, closing off the Diesel air supply and opening the carburetor passage; and engages the magneto. It can now be cranked as a gasoline engine. When the engine has made 700 revolutions, an automatic lever releases the starting mechanism and the engine operates on its Diesel cycle.

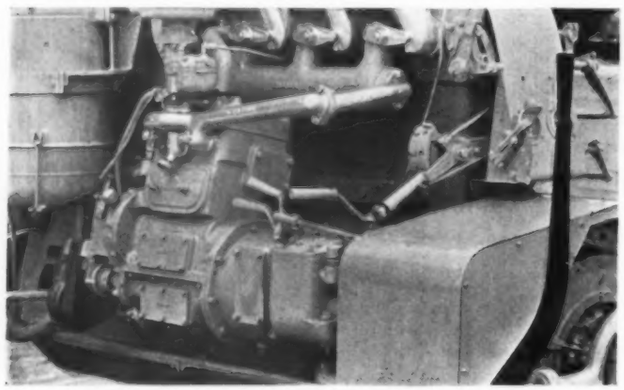


Fig. 44—Partial view of the Caterpillar Diesel showing the 2-cylinder gasoline starting engine and engagement mechanism.

The Diesel of Fig. 35 also is arranged to start as a gasoline engine. A hand control closes the large valve shown in the intake manifold; opens the inlet valves and holds them open slightly, thus placing the now closed portion of the intake port in communication with the cylinder with the proper compression ratio; opens a gasoline valve admitting gasoline to the carburetor; and engages the magneto. When the engine is turned over by hand cranking or an electric starter, the suction in the cylinder and closed port causes gasoline vapor to be drawn in through the small automatic inlet valve from the carburetor and the engine operates as a gasoline engine. The hand control is reversed, returning the engine to Diesel operation.

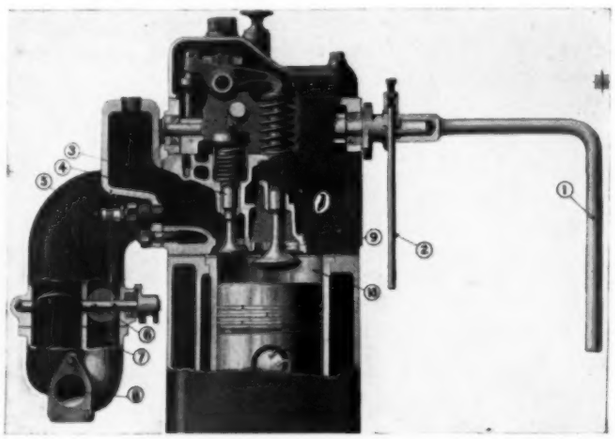


Fig. 45—Section through the auxiliary combustion chamber and communicating valve with the linkage designed for gasoline starting of the I. H. C. Diesel

Electric starting has been extensively employed to start the Diesel directly and usually necessitates a 24-volt battery with suitable starting motor and generator. In the engines shown in Figs. 29, 30, and 33, there will be noted a glow plug projecting into the combustion chamber which is heated electrically while the starting pedal is engaged and automatically disengaged when the engine is started. These may be started without this feature but so much more quickly particularly in cold weather if they are employed.

Comparative Economics of Diesel and Gasoline Engines

It is a widely heralded fact that Diesels operate on fuel costs which are only a fraction of those of the gasoline engine and this feature has given the main impetus to their development and success. If there were no other factors involved, the gasoline engine would have been discontinued immediately upon the advent of the high-speed Diesel, or which is more probable, would

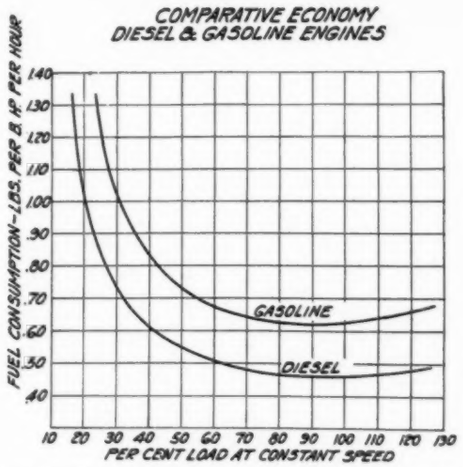


Fig. 46—Fuel-consumption curves of comparative tractor engines given in pounds of fuel per horsepower per hour. From this data it will be seen that, from 30 per cent load up to 20 per cent overload, the Diesel consumes about 75 per cent as much fuel by weight or about 60 per cent as much by volume as the gasoline engine and the ratio is quite constant.

doubtless never have attained its high state of perfection and success. Many engine manufacturers are far from conceding the entire position of the gasoline engine in heavy-duty equipment to the Diesel engine although they recognize the place of the Diesel. While Diesel production has been increased in a great measure during the past few years, yet when we compare the number of gasoline engines of the heavy-duty type and the number of high-speed Diesels produced during the past year, the latter is by far less than the former. A good deal of misrepresentation has been made by some which cannot really benefit the Diesel engine industry. An attempt shall be made to classify the factors entering into the comparison of Diesel and gasoline engines on a cost basis.

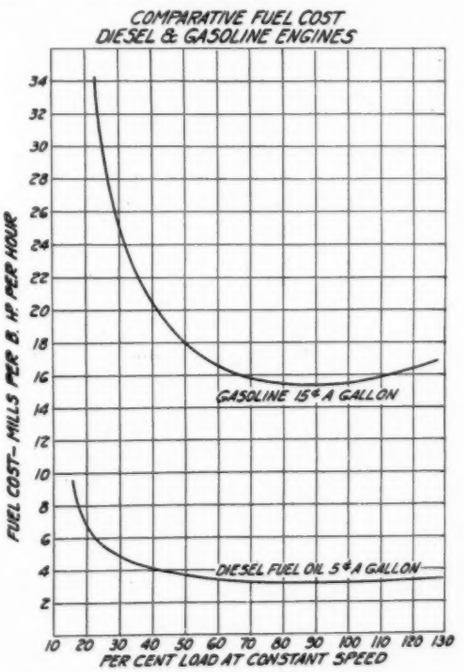

COMPARATIVE FUEL COST
DIESEL & GASOLINE ENGINES
FUEL COST - MILLS PER B. HP PER HOUR
GASOLINE 15¢ A GALLON
DIESEL FUEL OIL 5¢ A GALLON
PER CENT LOAD AT CONSTANT SPEED

Fig. 47—When the fuel-consumption curves are reduced to a cost basis per horsepower per hour, the fuel cost of the Diesel according to the data is about 20 per cent as much as that of the gasoline engine.

Comparative Fuel Costs—The three factors entering into the greatly reduced fuel costs are: (1) the better economy of the Diesel cycle expressed in terms of a lower weight of fuel consumed per horsepower per hour; (2) the greater weight per gallon of Diesel fuel which is an economy since fuel is purchased by volume; and (3) the lower price per gallon of fuel oil. In Fig. 46 is plotted a fuel consumption chart of two comparative engines and if the curves be compared it will be found that the fuel consumption *by weight* of this particular Diesel was about 75 per cent of the gasoline engine and is quite constant at the higher loads, becoming less at the lighter loads. But upon the entry of the second factor the Diesel is shown with an even less percentage. When a gallon of fuel is purchased, one receives a certain number of heat units in the fuel oil or gasoline. While the number of heat units in the two fuels may be considered equal when compared on a weight basis, the Diesel fuel possesses about 27 per cent more heat units per gallon of fuel because of its greater density or greater number of pounds per gallon. If the 75 per cent by weight basis be transferred to a gallon basis, the Diesel engine under consideration will consume about 60 per cent as much fuel oil as the gasoline engine consumes gasoline.

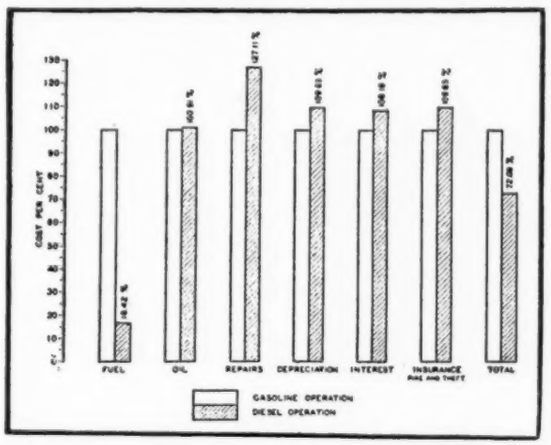


Fig. 48—Graphical representation of operating data obtained in motor fleet operation showing the comparative costs of gasoline and Diesel power in the various departments and total. Gasoline-engined trucks serve as the basis of comparison and is represented as 100 per cent in each case. (From The Oil and Gas Journal)

From a number of road machinery manufacturers consulted, this figure would appear quite conservative. Some report the Diesel engine, installed in the same type of equipment and operating under the same conditions, as consuming as low as 40 per cent as many gallons of fuel as a gasoline engine, while others report a figure of 50 per cent. It should be understood that should the price of Diesel fuel and gasoline be the same there would still be this saving. But this of course is not the case and a fair ratio between the two at present is 6 to 15 cents per gal. In the curves of Fig. 47 (which incorporates the three factors outlined), the ratio was 5 to 15 cents per gal. and shows the fuel cost of the Diesel to be about 20 per cent of the gasoline fuel engine cost. Others divide it roughly into one-half as much fuel at one-half the price which gives about 25 per cent.

In the operation of a grader of the same type and under the same conditions by Diesel and gasoline engines, it is reported that the fuel cost of the Diesel was

but 16 per cent of that of the equivalent gasoline engine. It has also been stated that the percentage has been found to be somewhat more favorable for the larger units than in the smaller ones. In the chart of Fig. 48, which represents data collected on the West Coast in heavy trucking equipment and reported at a recent American Petroleum Institute meeting, the fuel costs of the Diesel-powered trucks was but 16.42 per cent of that of the gasoline-powered trucks under comparative conditions.

Other Elements—If the only factor involved was fuel cost, the gasoline engine would have no market for industrial equipment. But this is not the case and reference is again made to Fig. 48 which tabulates graphically the comparative costs of the various factors involved. The Diesel must necessarily be a higher-priced machine because (1) the higher cylinder pressures require a heavier engine throughout; (2) the injection apparatus is much more costly than the carburetor and electrical equipment it replaces and will always be so; and (3) the quantity production of the Diesel is much less, which of course can be reduced as a factor. Roughly the Diesel engine at present cost twice as much as its equivalent gasoline engine and this becomes an important factor in overall cost of power. But when the total price of equipment and engine is considered, the increased cost is reduced in some cases to about 10 per cent more for the Diesel machine. According to the data charted, the cost of the Diesel was higher in every factor except fuel costs, and gave an overall cost of operating Diesel-powered equipment to be 72 per cent of that to operate gasoline-powered equipment. Even this gives marked overall saving for the Diesel.

The Load Factor—The load factor of a particular machine has been defined as the ratio of the average power to the maximum power during a given period of time. When one therefore considers whether or not to purchase a Diesel engine, other things being equal, he must estimate how much he will use the engine as all the factors are not constant. The elements of fuel and oil will vary directly according to operation but those of depreciation, interest, insurance, and doubtless repairs will increase per hour of operation as the engine is used less. This will reduce the overall saving in Diesel application and should be considered. One manufacturer who sells the equipment with either type of power unit and whose Diesel machine costs about $1000 more than the gasoline machine, reports that a purchaser's selection generally is determined by whether or not he has enough work ahead to pay off the difference by his fuel savings in a reasonably short period of time.

The Hesselman Engine—A word should be said about the economics of this type of oil engine. As to fuel consumption considered by weight, the Hesselman engines occupies a point intermediate between the Diesel and gasoline engines. When fuel consumption in gallons is thought of, this engine incurs the same advantages over the gasoline engine as the Diesel since the same fuel is used. The same is true of fuel price. Therefore the fuel cost of this engine should be slightly greater than the Diesel and a good deal less than the gasoline engine because of the fuel it burns. As to first cost the Hesselman engine is about from 25 to 40 per cent higher than the gasoline engine but a great deal less than the Diesel. Thus there appears to be an economical place for this type of oil engine.

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SOME RECENT BOOKS ON DIESEL ENGINES

For Engineers, Executives, Purchasers, and Operators

Diesel Engineering Handbook

Edited by L. H. Morrison, Editor of *Diesel Power*. De Luxe Edition, 831 pages, 6x9-in., leatherette cover. Published by Diesel Publications, Inc., 192 Lexington Ave., New York, N. Y. Price, $5.00.

Although this volume is a well-illustrated, comprehensive treatise of 40 chapters dealing with all types and sizes of Diesel engines, a considerable portion of the work is concerned specifically with the description and design of the high-speed portable Diesel for industrial use while much of the remainder is of general interest. After a thorough historical survey, a chapter is devoted to the basic principles of the Diesel and then follow successive discussions of fuel-injection systems in use and combustion chamber designs with sketches. Passing over two chapters, the next of special interest includes illustrated descriptions of high-speed Diesels and their peculiarities. Some 30 pages is devoted to general engineering fundamentals of particular interest to this branch of the science. Six chapters may be thought of as dealing with the design of the various general parts of the Diesel engine and a discussion of present practice, in which all types of units share, although the small industrial Diesel is recognized.

Then follows an outline of the combustion process considering its chemical reactions and an extended discussion of fuel-injection pumps and nozzles, classifying them and describing the various constructions employed at present along with the principles and methods of engine governing. Fuel oils—their characteristics, ratings, and purchase considerations come next followed by a mention of fuel handling and filtering problems and equipment. A chapter is devoted to the lubrication of Diesel engines and the lubricants employed with their characteristics and care. Such accessories as found on engine air systems; engine cooling water systems; exhaust equipment; and starting systems are considered, including the type of equipment, and problems in portable service. Efficiencies and Economics; Indicating the Diesel or cylinder pressure indicators and diagrams; and Specifications and Tests are titles of succeeding chapters. Passing over some sections pertaining especially to the Diesel plant we come to those on Diesel Trucks and Tractor Diesels of special interest, including operating data, an outline of operating conditions, and description of various engines for such service. Later such chapters as Diesel Statistics; Maintenance Schedules; and Operating Procedure will be noted while those on Diesels for railtrain, locomotive, and aircraft service are of interest.

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Diesel Engines

By J. W. Anderson. First edition, 489 pages, 6x9-in., clothboard covers. Published by McGraw-Hill Book Co., 330 W. 42nd St., New York, N. Y. Price, $5.00.

The publishers describe the book as "essentially a practical treatment of Diesel engines, showing what they are, what they do, how to select them for specific purposes, and how to operate them. Gives a comprehensive picture

of American engines and some European, classifying them according to general service applications, describing them, explaining principles of operation, and discussing installation, operation and maintenance, performance, and selection."

While general in character, the book is of great value to those concerned with the production, application, and operation of the mobile industrial Diesel engine. After some introductory remarks on the Diesel engine and its history, and having presented some theoretical considerations on the Diesel cycle, the author views the automotive and mobile-machinery engines, giving their general characteristics and service requirements and then individual illustrated descriptions. Passing over the chapters devoted to the other types of Diesel engines, we come to that on design characteristics, discussing "some of the principles and essentials that are common to all Diesel engines," following which is a discussion on scavenging and air systems.

Perhaps the most important chapters are those on Combustion Chambers and Fuel-Injection Systems. Having mentioned the general requirements of combustion, the author proceeds to sketch and discuss in classified form the various combustion-chamber shapes. Fuel-injection methods are outlined and described under headings of the common-rail and the pump-injection systems; the fuel pumps of various makes are presented as to principle with mention of special fuel systems; followed by the consideration of spray valves and nozzles. A long chapter on general design details follows and then, in their order, are discussed the following: governors and controls; water-cooling systems; lubrication and lubricating systems; fuels and fuel systems; starting systems; installation; operation and maintenance, briefly considered; performance and cost of operation; and finally, some aids in engine selection.

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Diesel Operating Guide

By JULIUS ROSBLOOM. First edition, 544 pages, 5x7-in., semi-flexible covers. Published by Diesel Engineering Institute, 443 Hoboken Ave., Jersey City, N. J. Price, $5.00.

The author has issued many books of a practical nature on Diesel engineering. One of his later books, Diesel Hand Book, is written in the question and answer method. His new book emphasizes more than the previous ones the operating point of view with mention of the problems encountered, and while the stationary engine is primarily in view, several chapters are devoted specifically to light-weight Diesels and much of the remainder is equally applicable. After outlining the types of Diesel engines and comparing the Diesel and gasoline-engine cycles, the author mentions some important factors of maintenance. He then outlines starting and operating procedure, explains the various parts of an engine and their functions, and states various troubles or effects and their causes.

Entering the subject of lubricating oils, their origin, history, and composition are given along with the many desirable characteristics, standard tests of quality, and methods and devices for purification. Passing over the sections on hydraulics and waste heat recovery we come to that on general auxiliaries and accessories which contains useful items. In the section, Questions and Answers, matters of maintenance, general electrical data and definition of terms, atmospheric data, fuels and lubricants, etc., are asked and discussed. A section further discussing accessories and their usage appears next followed by one on figuration giving horsepower formulas and other means of computation. The chapter on light-weight Diesels is occupied with the description of the engines of four manufacturers, with the description of several tractors and trucks, presenting cost data and economics. Sections follow on Diesel locomotives and railcars and such engines, while the final one is occupied with the properties of monel metal and copper for Diesel use with hints on the use of brass and copper piping.

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Diesel and Other Internal-Combustion Engines

By HOWARD E. DEGLER, Professor and Chairman, Department of Mechanical Engineering, University of Texas. New revised edition, 242 pages, 5½x8½-in., clothboard covers. Published by American Technical Society, 850 E. 58th St., Chicago, Ill. Price, $2.50.

As indicated by the title, this small volume is concerned with all kinds of internal-combustion engines but more particularly with the principles and various types of Diesel engines. Beginning with the steam engine, the author outlines the development of gas or Otto-cycle and Diesel engines, mentions their efficiencies and differences. The thermodynamics of these cycles illustrated by sketches and sample calculations are discussed next. In considering available fuels for internal-combustion engines, gaseous fuels and more particularly the liquid fuels of crude petroleum are mentioned, along with their use in carbureting and injection engines.

After having devoted a chapter to gas and gasoline engines of the diversified types and duties, the author comes to the subject of oil engines and presents (1) low and moderate pressure oil engines of the single-cylinder type; (2) somewhat extensively, the stationary Diesel; and (3) the high-speed type including description of several industrial engines. A brief chapter covers the requirements and elements of a fuel-injection system, describing typical designs while another is devoted to details of engine parts. The work is concluded by chapters entitled, Testing and Performance; and The Economics of Diesel Power, with practical problems.

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Diesel Engine Design

By HAROLD F. SHEPHERD, Consulting Engineer. First edition, 227 pages, 6x9-in., clothboard covers. Published by John Wiley & Sons, Inc., 440 Fourth Ave., New York, N. Y. Price, $3.50.

As the title suggests, this book is written for those interested in the design phase of the Diesel industry and is a brief technical treatise dealing with those factors to be considered in the design of the various engine parts, the best methods of calculation that the author has found, most useful formulas, test data of interest, and specific recommendations from present practice.

The historical portion contains extracts from some important patents of interest and narrates outstanding facts of interest to the designer. The subjects of combustion and fuels are entered upon next followed by a discussion of piston and piston-ring design and an illustrated account of the type of combustion chambers for small engines. The fuel nozzle and the classification of designs are next considered in all its phases with data, computations, and advantages, while the succeeding chapter deals in a similar manner with the fuel pump. Sections are then devoted to the following: the design of governing apparatus, cylinder heads, valves and valve gearing, and starting; the two-cycle engine and a related study of the gas engine; bearings, pistons, and rings, and their lubrication; the indicator diagram; inertia and balancing; the flywheel; and finally the crankshaft with design formulas.

A General View of the

ARBA CONVENTION &

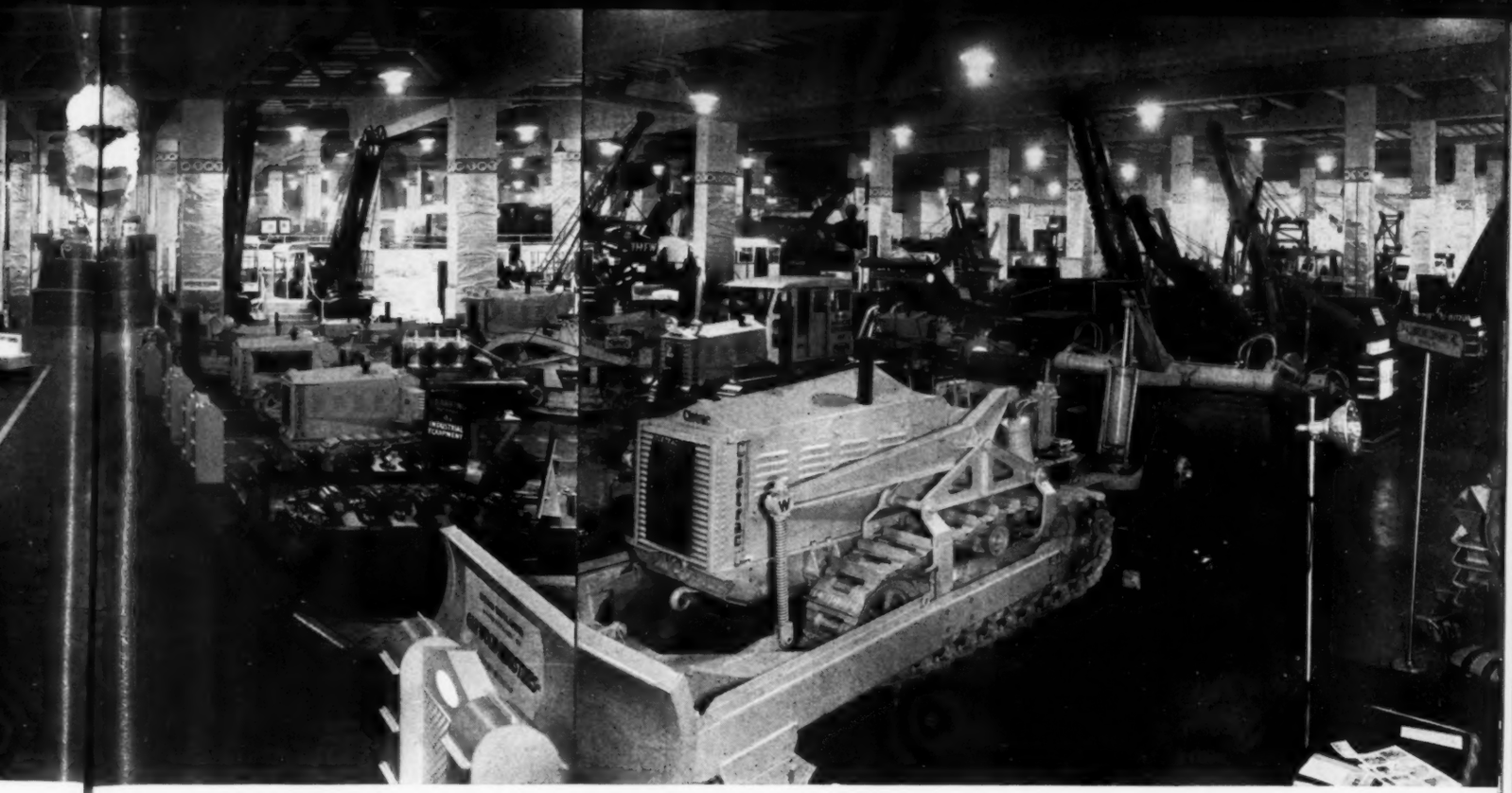
Old and New Officers
Left to right: William P. McDonald, Retiring President; Charles M. Upham, Engineer-Director; Willard T. Chevalier, New President

EVERY meeting of men has its dominant note or mood, and at the road show and convention at Cleveland, January 20 to 24, the unmistakable dominant was *confidence*. It showed in faces, in voices, in discussions, and not least in the character and scope of the displays.

In floor area, the show was somewhat smaller than its largest predecessor, but in quality it was far superior. The accompanying pictures give a suggestion of its character but fail to do it justice—in the first place because even the best of photographs is inadequate, and secondly because, to our regret, we were unable to secure views of some of the finest exhibits.

Conspicuous in comparison with other road shows was the lesson in showmanship learned from the Chicago World's Fair of 1933 and 1934. With few ex-

1. *U. S. Steel Corporation Subsidiaries*
2. *Chevrolet Motor Company*
3. *Littleford Brothers*



Heavy Equipment Section

ROAD SHOW 1936

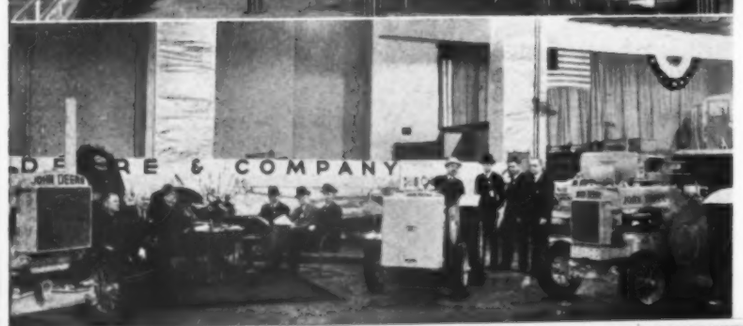
At the Convention
Left to right: J. A. Long, Jacksonville, Florida; Robert B. Brooks, St. Louis, Missouri; G. D. Kennedy, Lansing, Michigan

ceptions the exhibits were colorful, snappy, and designed to show the products to the best advantage. Many were the work of nationally known display experts.

It is impractical to describe here the 200 industrial exhibits; but brief reference may be made to the federal, state, and foreign displays.

The center of the Bureau of Public Roads Section was a large, illuminated map of the United States, with a striking highway picture covering the area of each state. On each side of this were four dioramas, the series of eight illustrating the progress of road development from pioneer days to date. The back of this display, which was visible from the lower level, where heavy equipment was located, was covered with inscriptions pertinent to the nation's highways. With the exhibit were shown instruments for determining subsoil

4. Cleveland Tractor Company
5. The Ohio Oil Company
6. The Barrett Company



conditions on road work—one by electrical and another by seismographic methods.

In the room devoted to educational and special exhibits, the Works Progress Administration had a large and beautiful model illustrating the development of farm to market roads. In this section, also, were the attractive and much-frequented Mexican pavillion, the booths of Cuba, Canada, the Province of Quebec, the states of Ohio, Missouri, Washington and Nevada, and Cuyahoga County. The Ohio display gave an excellent presentation of the work of the State Highway Department. Missouri occupied one entire wall with a series of safety exhibits. The National Highway Users' Conference, National Safety Council, University of Pittsburgh, Cleveland Police Department, and Aetna Casualty and Surety Co. were also located here—the two last named combining in a unique safety display and demonstration which was seldom without a crowd.

"The Little Theater on the Ramp" was a miniature movie house in which at stated times each day pictures were shown of various highways, road building operations, and the production of road building equipment and materials. There were 43 different shows, most of them 30 minutes long.

Moving pictures in the hooded box type of display equipment were used extensively by exhibitors of all sorts of products; and one manufacturer even went so far as to provide its own little theater where guests could sit and watch successive reels depicting the design, manufacture and use of equipment.

The general arrangement of the show deserves explanation. Located underneath the Cleveland Public Auditorium and adjacent streets and open spaces, there was nothing of the underground in its appearance. One entered by way of the educational and special exhibits section, passed through a wide corridor containing telephones, telegraph stations and post office, into Section H, where a group of the lighter weight exhibits were located, then down broad steps and at an angle to the left through the arcade, with a row of exhibits on each side, another angle to the left, and down a few more steps to the main exhibition hall. This hall, in turn, is divided into two levels, the shovels, cranes, and other tall equipment being located on the lower, where headroom is greatest.

The total registered attendance was 16,150, and officials and old-timers noted that its character was distinctly superior: in other words, it was composed almost entirely of people directly connected with the highway industry.

The management deserves the highest praise for its effectiveness in arranging and managing the entire affair.

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Incidental Social Features

On the afternoon of Sunday, January 19, a Pan American reception was held at the Hollenden Hotel. Men and women from a large number of American countries attended.

A reception for European guests, of whom there were a considerable number, was held at the Hollenden on Tuesday afternoon.

The highway contractors' supper dance at Mayfair Casino on Tuesday evening was the gay event of the week.

7. *The Galion Iron Works & Manufacturing Company*
8. *The Dow Chemical Company*
9. *Schramm, Inc.*
10. *Hercules Powder Company, Inc.*
11. *The Marion Steam Shovel Company*
12. *Deere & Company*

A banquet at the Statler Hotel on Wednesday evening attended by several hundred road builders and their ladies was a most enjoyable affair. Dr. William E. Wickenden, President, Case School of Applied Science, was the principal speaker. Dr. John L. Davis, "The Will Rogers of the Ministry," kept the guests in an uproar, with a half hour or more of high speed humor. President William P. McDonald, Mayor Harold H. Burton of Cleveland, "Uncle Jim" MacDonald, known and loved these many decades by road builders throughout the country, and several others also spoke appropriately. Engineer-Director Upham presided.

An international ball at the Hollenden on Thursday evening concluded the social program.

Throughout the week a committee of Cleveland ladies provided entertainment for the large number of feminine visitors.

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Platform for American Highway Development

Recommended by National Highway Advisory Council and Adopted by the American Road Builders' Association at Its 1936 Convention

Below is a synopsis of the 10 planks of the platform adopted by the American Road Builders' Association for highway development during the period just ahead.

I. The maintenance of an adequate highway system depends upon the consistent conduct of a three-fold program, viz.:

1. Determination of traffic requirements.
2. The planning and construction of highways with maximum overall economy and safety, including economy to the user.
3. The financing of all highway affairs on a basis that takes into account the responsibilities of all three beneficiaries, i.e.:
   1. The general community.
   2. The owners of land benefited.
   3. Motor vehicle operators.

II. Diversion of highway funds—particularly gasoline taxes—is unjust and should be stopped. State laws should be enacted to this end, and Federal Aid should be made contingent on the prohibition of diversion.

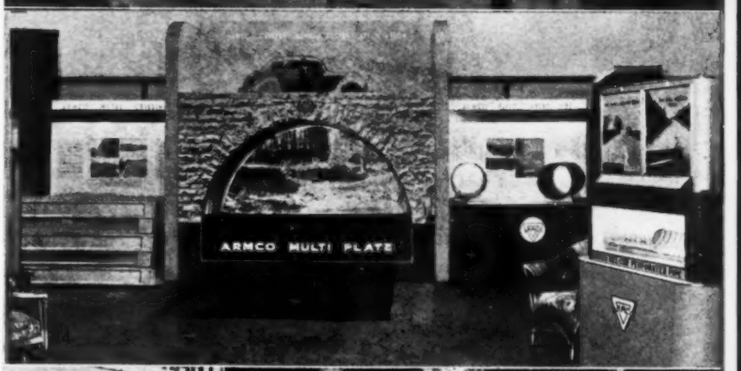
III. Continuance of the established Federal Aid program is advocated.

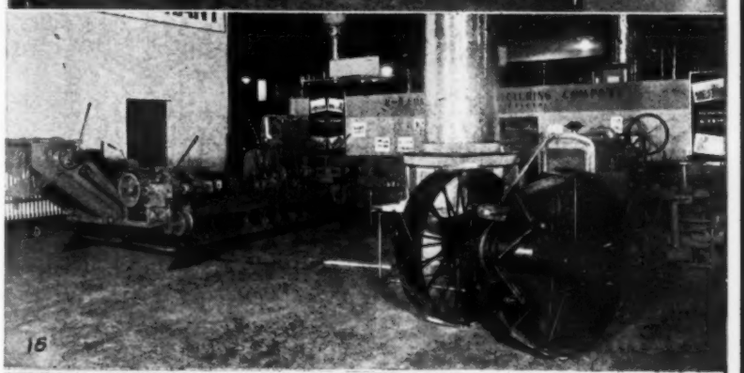
IV. It is recommended that emergency federal highway appropriations be not abruptly discontinued but that they be gradually tapered off until local jurisdictions can resume normal responsibilities.

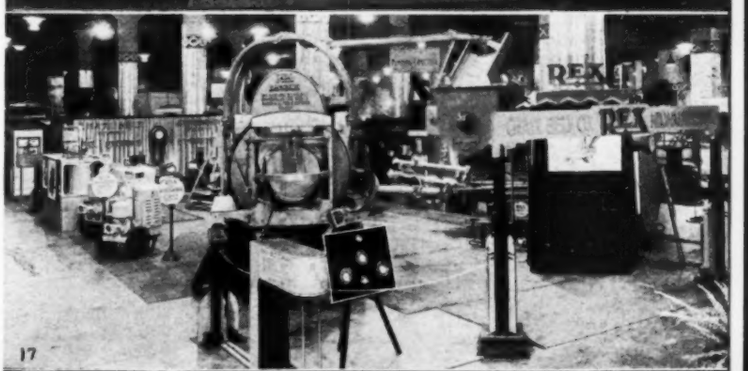
V. In the interest of economy and efficiency, it is urged that all federal appropriations for highways be administered by the Bureau of Public Roads.

VI. Immediate study is recommended to determine a sound and rational basis upon which to extend Federal Aid to secondary highways and through streets. Any Federal Aid to counties or municipalities should be conditioned on regulations which will maintain standards comparable to the standards developed through Federal Aid to state systems.

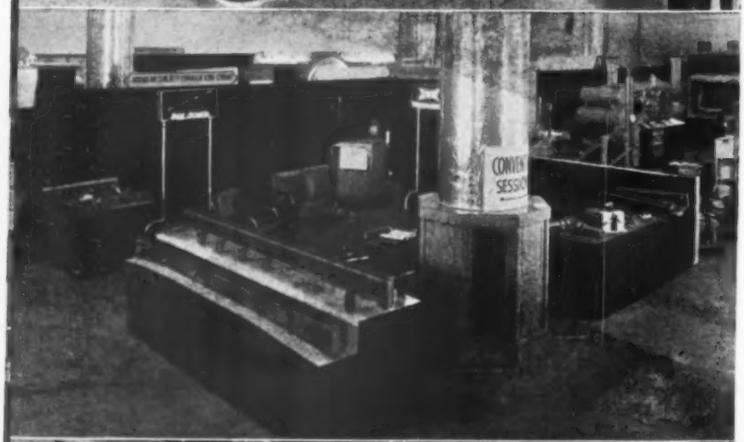
VII. To insure maximum benefit from motor transport of passengers and freight, it is urged that the construction and maintenance of all highways be entrusted only to competent and experienced officials and workers,







13. *J. D. Adams Company*
14. *Armco Culvert Manufacturers Association*
15. *R. B. Equipment Manufacturing Company*
16. *Sinclair Refining Company (Lubricating)*
17. *Chain Belt Company*
18. *Euclid Road Machinery Company*



and that they be not turned over to improvised organizations. It is especially urged that the contract system be used on new construction and reconstruction.

VIII. In the interest of public economy, it is urged that highway improvements be removed as quickly as possible from the status of unemployment relief, and that the use of modern methods and machines be restored wherever they have been displaced by primitive methods.

IX. Improvement of existing highways in the interest of safety is urged. This includes widenings, easier curves, grade crossing eliminations, and many other changes.

X. It is urged that in considering the effect of highway expenditures on the employment of labor, full value be ascribed to the labor involved in producing and distributing materials and machinery, as well as to the field labor employed in construction.

▼

Technical Sessions

Each forenoon and afternoon except Friday there were sessions of various technical groups in the special rooms provided for such purposes in the auditorium. Usually three or four of these were in progress at once. Below we give synopses of some of the papers presented. Others will be printed at length in future issues of ROADS AND STREETS.

Soil Stabilization With Bituminous Materials in South Carolina — By J. S. WILLIAMSON, State Highway Engineer, Columbia, S. C.

A considerable mileage of bituminous surface treatment of earth type base has been constructed in South Carolina. Mr. Williamson's paper describes this work. His paper includes descriptions of sand asphalt experiments, experiments with road oil, and the Jacksonville-Hemingway experiments. In the latter several different methods of soil stabilization were employed. The paper will be reproduced in a later issue of ROADS AND STREETS.

County Road and Resources Survey — By JOE E. BUTLER, Professor of Civil Engineering, Missouri School of Mines.

Professor Butler's paper was largely a progress report on a road and resources survey program covering a compact group of six counties in the Central Ozarks of Missouri. As planned the studies and necessary surveys were to be carried on by students in Civil Engineering at Washington University (St. Louis), the University of Missouri (Columbia) and the Missouri School of Mines (Rolla). The students were to receive thesis or other college credit for their work and to receive mileage and expenses from the State Highway Department for the necessary field work. A Professor of Civil Engineering (on non-pay status) from each school was to supervise the work of his students. However, the counties assigned to Washington University and the University of Missouri were so far removed from the schools that only hurried field reconnaissance surveys were found to be practicable. The report, therefore, deals mainly with the work of the Missouri School of Mines.

19. *Austin-Western Road Machinery Company*
20. *American Concrete Expansion Joint Company*
21. *A. Leschen & Sons Rope Company*
22. *Allis-Chalmers Manufacturing Company*
23. *The Hug Company*

Laying the Foundations for Future Highway Development—By M. W. TORKELSON, Director Regional Planning, Wisconsin State Planning Board, Madison, Wis.

In his paper Mr. Torkelson presents a plan for providing for highway development of the future. Its essence is to make provision, as early as possible, for all developments that can be foreseen through forecasts of population and industry, by taking steps to acquire right of way of ample and generous proportions which will include suitable provision for roadside improvement and to use any excess width acquired in advance of construction for landscape purposes until needed for traffic.

City Planning—By WALTER H. THOMAS, Director Philadelphia City Planning Commission.

Mr. Thomas reviewed certain aspects of the work done during the past two years by the City Planning Commission of Philadelphia, with the assistance of the Federal Government through its several agencies (the CWA, LWD and WPA). With Government contributions to date of over $600,000—and with an average daily employment of approximately 200 men and women, many of exceptional technical training, it was possible to explore in detail into many phases of city planning that for economic reasons must generally be overlooked, in spite of their essentiality to a true and basic understanding of the problem as a whole.

Extension of Our County Highway System—By DALLAS SULLIVAN, Legislative Agent and Budget Director, Ohio Good Roads Federation.

In presenting his paper Mr. Sullivan said it would be his purpose to endeavor to state definitely:

That the county road program is far from completed in Ohio. That local road revenues are inadequate. That Ohio needs a classification of local roads. That the local or secondary roads question is a state and a federal problem. That an increased local road program is necessary in Ohio.

He concluded his paper with the following suggestions:

"1. A united effort must be put forth by all local highway organizations for the purpose of protecting Ohio's local road revenues and a cooperation of these organizations with the American Road Builders' Association at Washington for the purpose of securing a federal appropriation.

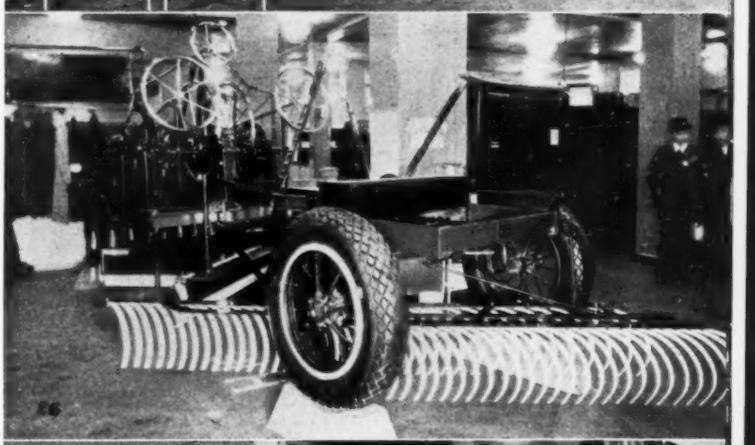
"2. By preventing any diversion of gas tax funds.

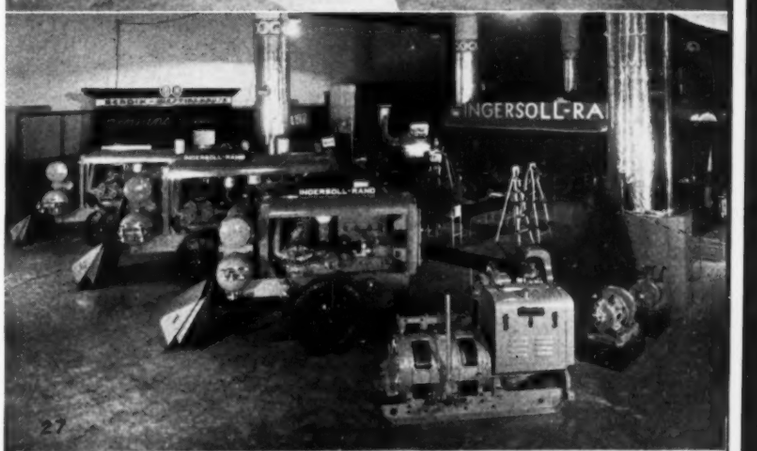
"3. By preventing any diversion of tag tax revenues by the re-enactment of laws that permitted this to be done or by the incorporation into any proposed law, the authority to use the funds for county or township purposes other than road or street improvements.

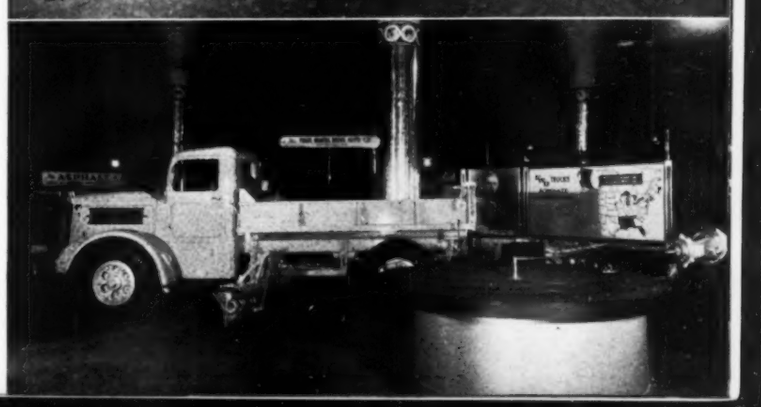
"4. By compelling the economic administration of our 1936 funds so that the general public will realize that these revenues have been expended honestly and economically for road purposes.

"5. By promoting during 1936 the road needs of 1937 and 1938 with a general educational program for the public.

"6. By coordinating the activities of road organization and highway industries with county and township officials so that the development of a continued road improvement program may be well understood and appreciated."

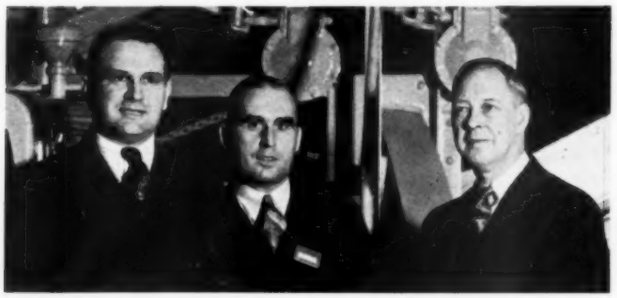






24. *Caterpillar Tractor Company*
25. *Waukesha Motor Company*
26. *York Modern Corporation*
27. *Ingersoll-Rand Company*
28. *The Four Wheel Drive Auto Company*

Association Members Came from Canada



Left to right: H. G. O'Connell, general contractor and president of H. G. O'Connell, Ltd., Montreal; J. B. McGuigan, Montreal manager of the General Supply Co. of Canada, Ltd.; G. Barclay Nicol, manager of the machinery department of the General Supply Co. at Ottawa.

Report of Committee on Regional Surveys and Plans — By JOHN A. LONG, Chairman, County Engineer, Duval County, Jacksonville, Fla.

This report dealt with county and local planning, and with the progress and planning of work under the National Planning Board of the PWA. It recommended the adoption of the A. R. B. A. County Planning Manual by the various state planning boards.

Sources and Distribution of Highway Revenues— By F. W. LOVEJOY, U. S. Bureau of Public Roads.

Mr. Lovejoy reviewed briefly the history of highway development in the United States from colonial days, then took up the subjects of revenues and expenditures. An important part of the paper was devoted to a consideration of the fair and proper distribution of funds between main and secondary roads, and also between city and country. Regarding taxes and road usage, Mr. Lovejoy spoke in part as follows:

"This perhaps is the place to mention one outcome of surveys already completed in Illinois, New Hampshire, and Wisconsin, which showed the rural resident paying bigger proportions of all taxes and imposts spent on all roads and streets than the urbanite, by from 2.3 per cent to 15.0 per cent, if compared with their respective usage of all roads and streets. The Michigan survey indicated almost exactly proportionate expenditure of tax payments and usage by ruralite and urbanite. In other words, according to these first four surveys, the city dweller appears to be coming out pretty well, when the expenditure of his proportion of tax payments is compared with the road service he utilizes. Another thing to remember is the downward trend of street expenditures compared with total municipal cost payments, exclusive of debt service, reported by the U. S. Bureau of the Census. The percentage of street expenditures dropped from 19.6 per cent in 1905, to 17.0 per cent in 1925, to 14.4 per cent in 1931, for cities over 30,000 population. The records were changed in 1932 to apply only to cities over 100,000 population, but the street expenditures still continued to drop from 11.6 per cent in 1932 to 9.5 per cent in 1933. So there has evidently been a smaller and smaller proportion of city cost payments made on account of streets."

29. *United States Bureau of Public Roads. Diorama of Arterial Highway Into Large City. Photo by Courtesy of the Bureau.*
30. *Scintilla Magneto Company, Inc.*
31. *The Geneva Metal Wheel Company*
32. *Calcium Chloride Association*
33. *Bethlehem Steel Company*
Kalman Steel Corporation

Mexican Members Participated

Left to right: Jose Rivera, general manager, Mexican Automobile Association; George Galvez, sub-director of highways; Ignacio Avilez, chief construction engineer of Mexican railways.

Stabilization and Mix-In-Place Methods — By THOMAS E. MORGAN, Assistant Division Engineer, Ohio Department of Highways.

Mr. Morgan presented an interesting series of lantern slides showing methods in use in Ohio. He laid special stress on elimination of the nuisance of excess tar, oil, or asphalt in such work.

Recent Developments in Street Railway Track Paving in Cleveland—By GEORGE B. SOWERS, Consulting Engineer, Cleveland, Ohio.

The speaker discussed the present condition of track, most of which was built between 15 and 25 years ago, pointed out that road beds are well consolidated and generally better than when laid, that rails, pavements and a part of the ties are in general the only portions which are worn out, and even these often have a considerable salvage value.

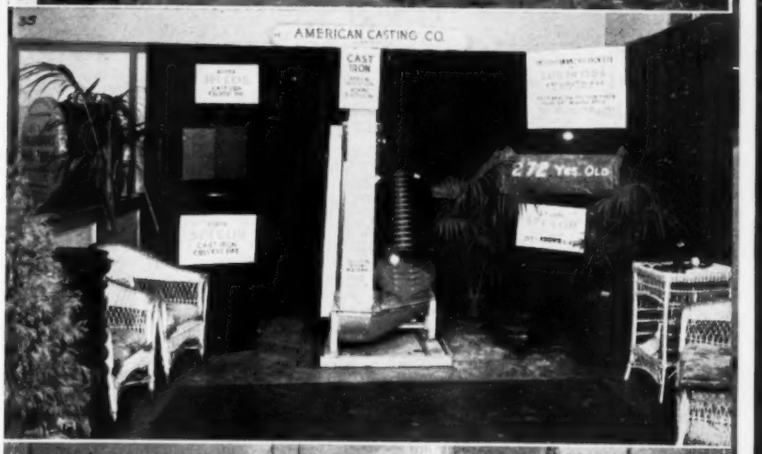
Regarding flexibility and rigidity, Mr. Sowers said:

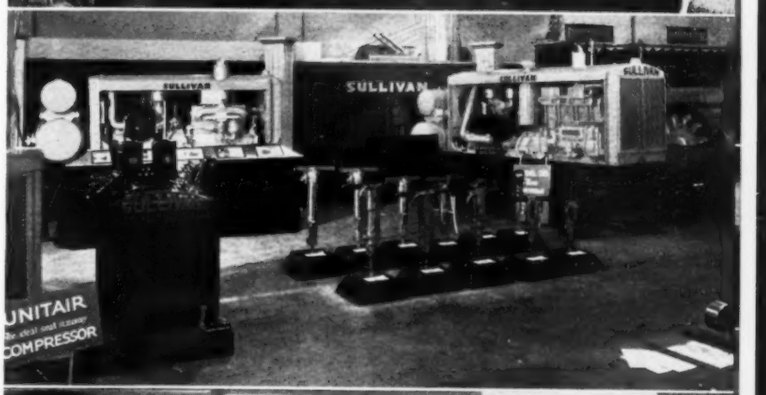
"The same degree of flexibility or rigidity should be built into both the track and its pavement, and the more flexible track area separated from the more rigid pavement in the balance of the street. A rigid pavement cannot be successfully combined with a so-called flexible track. The wave motion in the rail independent of the pavement will sooner or later loosen and break up the track pavement allowing water to enter and hasten its destruction. Much of our track pavement trouble in the past has been due to the attempt to place a rigid pavement in a track which was built with, or later acquired, flexibility.

"The greatest life and economy in a street railway track and pavement can only be secured when the pavement, the rail embedded in the pavement, the foundation and the ties act as one structure and deflect as a unit under the vehicle loads.

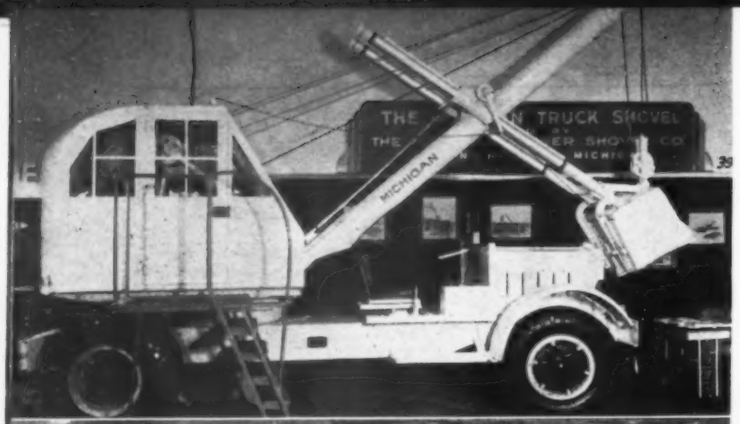
"To accomplish this end this has been the quite evident aim of the engineer of The Cleveland Railway Company in their track development work of the past few years.

"The development of types of track and pavement construction reusing the old foundation and subgrade without lowering the quality or reducing the load-carrying capacities desired today in street railway tracks and pavement is conservatively estimated as having saved the car riders of Cleveland the interest on an investment of more than $150,000 during the single year of 1935."





34. *United States Bureau of Public Roads. Diorama of Land Service Roads. Photo by Courtesy of the Bureau.*
35. *American Casting Company*
36. *Sullivan Machinery Company*
37. *Koppers Products Company*
38. *Interlake Iron Corporation*



Pavement Design and Construction—By OTTO S. HESS, Engineer - Manager, Kent County Road Commission, Grand Rapids, Michigan.

Mr. Hess' paper dealt with portland cement concrete, brick, bituminous pavements and bituminous retreads, with particular emphasis on these types as applied to country roads. Repetition of matter already adequately covered in print was avoided, attention being given chiefly to the more recently developed design and construction features.

Otto S. Hess

Highway Safety Lighting—By KIRK M. REID, Nela Park Engineering Department, General Electric Company, Cleveland, O.

After pointing out that there were 12,600 traffic fatalities in 1934 on rural highways at night; that is, over one-third of all traffic fatalities—both urban and rural, day and night—occur on rural highways at night, Mr. Reid went on to say:

"Analyses made in five states show that traffic fatalities by day are decreasing slightly, but that night fatalities are increasing appallingly. The problem is to reduce the after-dark hazard.

"Samplings indicate that three-quarters of the rural traffic fatalities at night occur on only 50,000 miles of highway, or less than 10 per cent of the mileage of surfaced highway.

"On this limited mileage the accident rate per vehicle mile at night is 6 times that by day, and the fatality rate at night is 10 times that by day.

"Experience indicates that fully one-half of night accidents on rural highways can be prevented by proper safety lighting.

"The use of safety lighting on the 50,000 miles of most hazardous and heavily traveled highways would save, each year, at least 5000 lives, 50,000 personal injuries and 100,000 cases of property damage. And this at a cost of less than one-third the loss from the preventable accidents.

"This opportunity for the conservation of life, limb and property has stimulated extensive researches directed to the problem of providing the most effective seeing on the highway at the lowest possible cost.

"Among these researches are the development of the sodium-vapor lamp which now produces almost three times as much light per watt as MAZDA lamps, and the studies on the Nela Park laboratory model highway of fundamentals of seeing on the highway. The results of these latter studies are embodied in the demonstration installation on U. S. Route 422 fifteen miles from Cleveland Public Square. The seeing and safety provided by this installation, employing incandescent lamps, could have been equaled under past systems only by providing several times as much total light.

"Each state should be gaining experience with safety-lighting installations as a means to a major reduction in traffic accidents."

39. *Michigan Power Shovel Company*
40. *Rockford Drilling Machine Company*
41. *Harnischfeger Corporation*
42. *Lima Locomotive Works, Inc.*

H. G. Sours

Federal Funds for Local Road Construction. — By H. G. SOURS, Engineer of Summit County, Akron, Ohio.

Mr. Sours treated of county needs, compared the sources of funds available by states and counties, presented arguments for the local control and supervision of local roads, pointed out that gasoline tax diversion has been of much more serious consequence to county roads than to state highways because the former have received very little in federal funds, recommended federal aid for counties, cited the necessity for many counties to develop and train competent engineering forces to handle such work, and suggested that the Bureau of Public Roads act as supervisor until such forces are developed.

Making a Regional Plan—Considerations and Procedure—By WILLIAM H. CONNELL, Executive Director, Regional Planning Federation of the Philadelphia Tri-State District.

The author of this paper gives a synopsis of the general principles of regional planning, and follows with a comprehensive statement of the general considerations involved in making the regional plan of the Philadelphia Tri-State District.

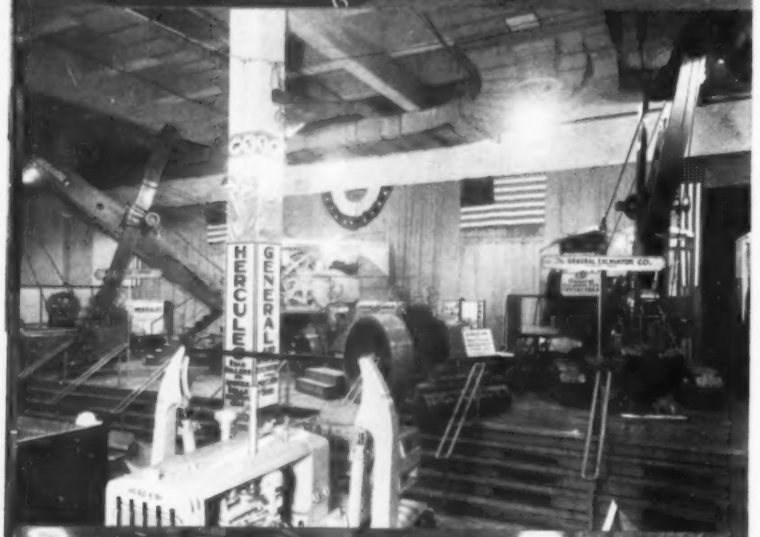
It is planned to reproduce portions of this paper at some length in a future issue of ROADS AND STREETS.

The Effect of Federal Government Regulations on Cost of Highway Work—By FREDERICK HOITT, Secretary, New England Road Builders' Association.

This paper presented a criticism of federal regulations of wages, hours and personnel on road work under the Emergency Relief and Reconstruction Act and the National Industrial Recovery Act. Mr. Hoitt reviewed the history of the acts, with special reference to the adverse effect on contractors of the 30-hour week and other time restrictions, the guarantee of man-hours, the agitation for restriction of machine operation, employment list regulations, and wage regulations. In his concluding section he says:

"Having in mind that a study and analysis made by the Bureau of Public Roads showed that when the work was done under conditions of the highest efficiency and economy 91 cents of the road construction dollar went to labor and services either directly on the job, or indirectly in the production of materials, manufacture of machinery, transportation services, and through other channels, I have often wondered just how much better result than that has been obtained by all this regulating and restricting of contractors, and regulating, restricting, manipulating, shifting and juggling of labor. The money has possibly been spread among more workers, but in thinner portions and under conditions that discriminate against the skilled worker in favor of the unskilled. If more direct employment on the work has been furnished, the amount of indirect employment has been decreased.

43. *The Byers Machine Company*
44. *Concrete Surfacing Machinery Company*
45. *Trackson Company*
46. *The Thew Shovel Company*



Bituminous Soil and Base Stabilization—By F. V. REAGLE, Engineer of Materials, Missouri State Highway Department.

Mr. Reagle dealt briefly with the history of earth, stone, and gravel roads in Missouri, discussed problems encountered in securing a base to withstand the effects of water, and described at length two types of base stabilization with bituminous materials trial installations of which have recently been made. This paper will be reproduced in a forthcoming issue of ROADS AND STREETS.

The Works Progress Administration and Farm-to-Market Roads—By PERRY A. FELLOWS, Assistant Chief Engineer, Works Progress Administration.

Mr. Fellows' paper was divided into three main sections—"New-Roads Frontier," "What Should the Planning of Roads Comprehend?" and "Policy." The following is quoted from the concluding section:

"The policies which control the Works Progress Administration activities in connection with projects for highways, roads and streets are the same as those that control the Works Progress Administration activities in connection with other types of public works. The primary purpose back of the interest in these projects is the creation of work opportunities for people who are employable but who are without work and who are destitute. The basic policies are shaped to accomplish that purpose.

"The people who thus qualify for work are known. Their skills have been determined, the location of their homes has been established. The amount of money available from Federal funds for this employment is also known. The possibilities for employment of all these people with the available funds are limited by the factor of time. In order to make it possible to provide at least the minimum amount of money to each employee from month to month the program is limited in general to those projects which can be completed within the period.

"Since the purpose of providing employment is to maintain morale, the selection of projects must be such that this purpose is not defeated. The employee must do the kind of work for which he is fitted. The work must be useful. It must be where the relief client can get to it. It should not be of a character to place him in unusual hazard or to endanger his life or health. From all these aspects, it must stand comparison with other projects.

"It is not the primary purpose of the Works Progress Administration to build roads or streets or similar projects. To the extent that road and street construction projects come within the requirements laid down to qualify all projects, they are acceptable. It is the policy of the Works Progress Administration to promote the wise selection of such projects and to advise in the planning and prosecution of the work."

47. *The Asphalt Institute*
48. *The Osgood Company*
Hercules Company
The General Excavator Company
49. *Bay City Shovels, Inc.*
50. *International Harvester Company of America*

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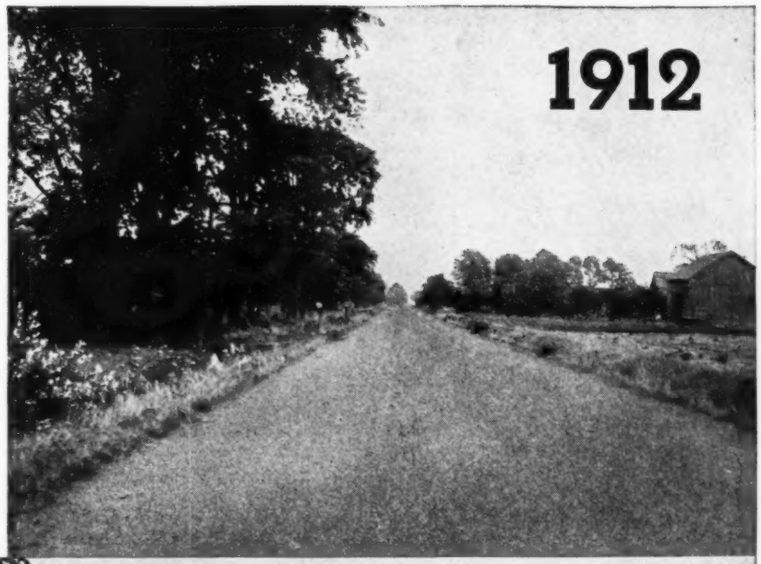

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BITUMINOUS SOIL AND BASE STABILIZATION

A PAPER PRESENTED AT THE 1936 CONVENTION OF THE AMERICAN ROAD BUILDERS' ASSOCIATION, AT CLEVELAND, OHIO

By F. V. REAGEL

Engineer of Materials, Missouri State Highway Department, Jefferson City, Mo.

THIS discussion will deal with specific research projects now under way in the State of Missouri together with a summarization of conditions leading up to the inauguration of this work.

In this connection, we desire to stress the fact that we are describing current research and are not presuming to draw conclusions at this early state although some of our good friends have already concluded both favorably and unfavorably. Any statements made in regard to road section conditions are to be considered as short time indications only, based on the relatively young age of the sections.

Early Experiments and Experiences

With the inception of our highway program in Missouri, we found ourselves with a large mileage of earth roads to be improved. Expense would not permit nor immediate traffic justify the construction of high type surfaces on secondary roads. Consequently a large mileage of traffic bound crushed stone and gravel roads were built to supply the demand for all weather surfacing. These surfaces served their purpose with, however, the attendant hazards of dust and loose surface material.

Experimentation in several states then produced the oil mat type of surfacing. A number of trial installations of this type on well established bases provided a sample of surfacing free from the hazards and inconvenience of the floating type surfacing and the sale was complete and immediate.

When a considerable mileage of this new type surfacing was placed on relatively stable gravel surfaces as a base, however, we soon discovered that, while a gravel mat can carry traffic and remain stable as a surface if the underlying moisture is free to come up through the surface and evaporate, the same mat when blanketed with a moisture tight surface was no longer uniformly stable. We had been carrying our traffic on a crust of one and one-half to two inches in thickness which seems to be the natural equilibrium mixture of gravel and subgrade soil when the former is applied to the latter according to the featheredge method.

Accordingly, we were faced with the problem of improving a large mileage of traffic bound surfaces and plain earth surfaces, which, in their existing conditions were not satisfactory as a support for a thin oil mat. The answer seemed to be either to improve the base support or to add additional layers of mat to provide the desired support by spreading the load over otherwise insufficient base support. To provide the necessary base support seemed the less expensive and was therefore adopted. Use was made of the clay-gravel stabilization method which will be discussed elsewhere during this meeting.

At the same time, thought was given to some form of chemical or bituminous stabilization for use in areas where additional gravel or other metal was expensive.

Moisture Problems

As has been stated elsewhere by the author, any consideration of the low cost road problem brings us to the realization that soil or subgrade support is the basic support with which we have to deal. If at the proper moisture content, the soil will support any practical load, which is true in the majority of cases, then the simple stabilization of the moisture content will achieve our purpose to the extent that such stabilization can be made permanent. It is a broad statement, but it follows, that if we can find a practical, durable way to stabilize the moisture content of soils in the field, we will need no other type of construction. Failing in this objective, the next step in design is to spread the load over sufficient area to meet the limited supporting power of the soil at the moisture conditions experienced, or else change the characteristics of the soil phase by adding friction material.

Our conception of the difference between base and surface is that bases are simply additional thickness protected against reduction in thickness from traffic action, by means of an additional layer (the surface) designed to resist the abrasive action of traffic. The protecting layers so far devised are in general more expensive than the bases, thickness for thickness.

If we are correct in our assumption that a durable water-proofed thickness of soil is of just as much value (aside from failure to resist the abrasion of traffic) as an equivalent thickness of high type surface (again discounting beam strength) we are forced to just one conclusion—concentrate on the base and work in the direction of water-proofed bases plus relatively thin renewable cover coats as a solution to our low cost road problem. We can get at the thin renewable surface to preserve or improve but it costs to work on the base after the top has been once placed.

This is the line of reasoning on which we are basing our plan of research attack on the low cost road problem.

As previously indicated, the problem is a large mileage of earth roads and worn out gravel and crushed stone roads of little thickness to be improved to give dustless, safe service to present and future traffic at a reasonable annual cost including maintenance expenditures.

Considering only the bituminous angle, can we add sufficient oil to a sufficient thickness to durably waterproof without inducing a plastic condition and thereby losing the inherent stability of the soil? If not, can the plasticity so induced be overcome by the addition of an economical amount of friction material?

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LORAIN-87
LORAIN • 95
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Big Capacity, Long Range Dragline • 1 1/2—1 1/4—1 yd. Diesels • 3/4—5/8—1/2—3/8 yard • Truck Shovels and Cranes

The use of soil-oil mixtures is not by any means new. We are told of earth asphalt bricks constructed by the Assyrians thousands of years ago and still withstanding the elements. Oils have been recently used to stabilize adobe brick in the western states with surprising results. Millions of gallons of oil are being applied annually to earth surfaces to provide, with proper renewal and maintenance, all weather roads with perhaps a greater return on the investment than any other form of surface under use today.

The novelty involved in our present work, if any, is the treatment of a greater thickness and perhaps some features of one of the methods of application.

Two different projects involving different methods of application will be described. We desire to repeat for emphasis that this work is as yet in a preliminary experimental stage; and while encouraging preliminary indications are shown, only a thorough service test involving time can give us any definite evaluation of our results.

Subterranean Method

The Ingles or subterranean method is a method for the deposition of a quantity of liquid bituminous material or other treating agent, at the bottom of a scarified layer of earth, or earth covered with granulatr surfacing, followed by compaction to permit the oil to permeate upward and diffuse through the mass.

This method in principle was, in so far as we know, first conceived by Mr. Ingles in connection with the hauling of heavy equipment in the western oil fields. Its first trial in Missouri was by Mr. Alex F. Sachs, County Engineer of Jackson County, on short stretches of earth, and earth covered with crushed stone surfacing. After promising indications were observed on these stretches constructed during the summer of 1935, ten miles of experimental sections were constructed on the Missouri State Highway system in Platte County.

The method as now developed consists essentially of scarifying the existing roadway to a depth of 4 or 5 in., followed by the introduction of the bituminous material with or without the prior or subsequent application of a small amount of water or soap solution. Following the application, the road way is kept smooth under traffic and rolled if necessary to obtain the desired compaction.

The equipment for application consists of a heavy frame supporting hollow curved teeth which projects down to the desired depth and through which the bituminous material from an accompanying distributor is forced by means of a pump mounted on the rear of the applicator.

The bituminous material added has included SC oils, MC oils, MC oils emulsified, and commercial emulsions. The quantities very from approximately three to seven per cent of oil by weight of the layer treated, based on the material passing the 40-mesh sieve and the 100-penetration residue of the treating oil. These quantities attempt to bracket the optimum quality or in other words to obtain some sections too lean and some too rich in order to obtain the maximum of information.

To a number of sections varying quantities of aggregate were added prior to scarification in order to test the efficiency of additional friction material in case too great a degree of plasticity was induced and also to check the relative efficiency from an economical viewpoint. The ranges of percentages of the material passing the 40 mesh sieve on the completed sections approximate 20 to 30 per cent, 50 to 60 per cent, and 100 per cent.

It seems to take about two to three weeks for the oil to permeate the mass, the final stage of diffusion seeming often to follow a rain.

The final result hoped for and apparently, from preliminary indications, obtained on certain of the sections, is a waterproofed layer from four to five inches in thickness. All granular material present in the surface seems to be well absorbed with the exception of a very small quantity of floating material.

It is apparent in our opinion that the final result is a base and not a surface but it is hoped that the base obtained, at a cost of approximately twenty-five hundred dollars per mile, will require only a light armor-coat as a surface, the resulting combination, if successful, being obtained at a considerable reduced cost as compared to other types of low cost construction in our state, in areas where aggregates are not readily available.

The project was constructed during the late fall during a rainy season and under conditions which were considered as distinctly unfavorable. Some sections, particularly those having little or no granular material present, have probably not yet had a complete drying action such as would be necessary for the best result.

The lateness of the season prevented application of trial sections of surface and consequently the base will be exposed to traffic throughout the present winter without surface protection.

To date the exposed base is showing little, if any distress, carrying traffic throughout its entire length.

The soil type is predominatly a silt with a few stretches of clay at low points in the grade line.

Traveling Plant Method

Since we were not certain of the success of this method, and as a check method, we tried, in Lewis County, a second method in which we scarified the surface, windrowed the material and mixed with the desired percentage of bituminous material by means of a traveling plant (Barber Green Type).

The variations tried with the first method, including added granular material, were approximately under this method but at a considerably increased cost. The advantages hoped for in the second method were greater uniformity, better mixing and better control. Only about six miles of the contemplated ten miles of test sections were completed before winter weather caused a shutdown but sufficient sections were constructed to give possibilities of an interesting comparison after the effects of traffic and weather during the winter season can be observed.

The previous remarks regarding weather conditions also apply to this project. Due to use of a pug mixer, it was necessary to add about 35 gals. of water per cubic yard of mixed material in order to obtain a dischargeable mix. This added water does not immediately leave the mix and a number of sections were not sufficiently dried to permit traffic prior to freezing and accordingly cannot be spread until next spring.

Sections which had a longer drying time are carrying traffic with little or no signs of distress. There is evidence, however, of a sponginess or rubbery action indicating that future additional consolidation will and should take place.

No surfacing or seal of any type has as yet been placed on any section of this project.

The predominate soil type at this location is clay.

The cost of treatment by this method will probably be about $4,000 per mile.

Physical and Chemical Reactions

Mention has been made of the use of soap in connection with this work. This addition is not primarily made in order to produce emulsification but for the

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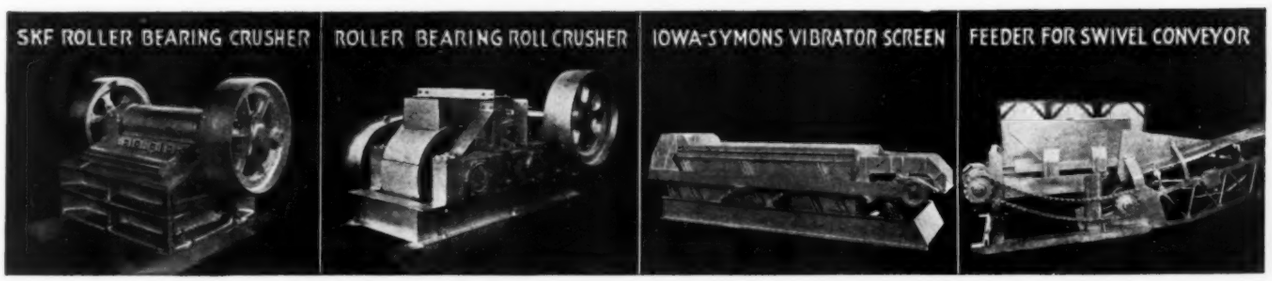


purposes of promoting a beneficial chemical action between the oil and soil surfaces.

It has been established that such an action does take place and a very interesting theory, involving the surface chemistry of the soil particles, is used to explain this action. It is beyond the scope of this paper to discuss this subject in detail but it is suggested that many of you may be interested in a paper by Dr. Hans Winterkorn who is engaged in a cooperative research on the chemical stabilization of soils and to whose work we are indebted for the development of the theory on which our more recent work is based. This paper will be delivered at a session of the Asphalt Paving Technologists to be held in connection with the present Road Show.

It might be of interest however, to give a general sketch of the reactions which we feel are of importance in a soil-water system and in a soil-water-oil system.

During the formation of a soil-water system, the dry soil is wet with varying degrees of difficulty, assuming the water to be added in small increments. The difficulty of wetting varies directly with the amount of surface area to be covered. In the case of a finely divided clay, the surface area will total at least an acre per cubic centimeter whereas silts and sands have decreasing amounts of surface, relatively small.

With increasing quantities of water, the stability curve of the system tends to drop. This drop in value increases rapidly at the lower plastic limit and drops to zero at the liquid limit. Any treatment that we can give to this system, therefore, that keeps the moisture content below the lower plastic limit, or which changes the character of the soil so as to move the lower plastic limit to a higher point will definitely improve the system.

The introduction of bituminous material to this system tends to do both.

In our resulting soil-water-oil system, we include the larger granular material in the term "soil." We include the constituent water in this system for three reasons; first, all earthy materials under natural conditions are covered by a film of water; secondly, it has been shown that a certain amount of water is necessary for a good oiling job; and finally, moisture is always present after the completion of the job, as its most destructive enemy.

The permanent stability of an oil-earth surface, or base, depends largely upon the relative affinity of the mineral surfaces included in the system, for oil and water respectively. If the affinity of the mineral constituents for oil is greater than for water, then the oil will be preferentially absorbed by the soil, preventing a detrimental reaction with water, whereas if the opposite preference is shown, an unstable system toward moisture will be formed.

There have been proposed and used several methods for measuring these relative affinities, generally based on measurements of interfacial tension and preferential wetability. According to most of these tests, stable oil-earth systems should be impossible of formation.

However, we have ourselves seen and constructed stable oil-earth roads. Apparently these tests neglect a very important factor, namely the composite nature of the constituents of the soil-moisture and oil phases.

It has been shown that there are dissolved and suspended in the soil-water as well as in the oil, large amounts of various surface-active substances, some of which possess the same general character or exhibit the same behavior as soap molecules.

This behavior, that of orientation, is best illustrated by the following well known experiment. A drop of molten fatty acid is put on a water surface. After solidification and removal from the water, whereas the portion which originallly solidified in air is easily wetted by oil. Apparently, while in the liquid state, the fatty acid molecules have arranged themselves so as to bring their hydrophil heads into contact with the water, and moved the more inert organic portion toward the air.

Obviously, determinations of the surface tension of highly viscous or solid fatty acid systems toward water or oil will vary according to the time allowed for orienation of the molecules. The same must be true of highly viscous asphaltic materials.

Based on the foregoing discussion we finally picture the following action as taking place in a successful bituminous soil treatment.

The substances dissolved and suspended in the oil, and which show greater affinity for water than do the oil molecules, but which are not entirely soluble in water will accumulate and be oriented at the oil water boundary. Vice versa, the same action happens with the substances dissolved and suspended in the water phase or film. The water film then gradually decreases in thickness by evaporation until the active oriented substances on the oil surface approach the soil particles closely enough to be strongly absorbed.

This oriented absorption brings about the greatest possible resistance for this type of system against further attack by water.

The use of soap or similar compounds in connection with the construction of bituminous road surfaces and bases is primarily designed to increase the amount of readily available surface active material which will be oriented to promote the establishment of a better oil soil linkage.

Largest Installation of Sodium Lights in United States

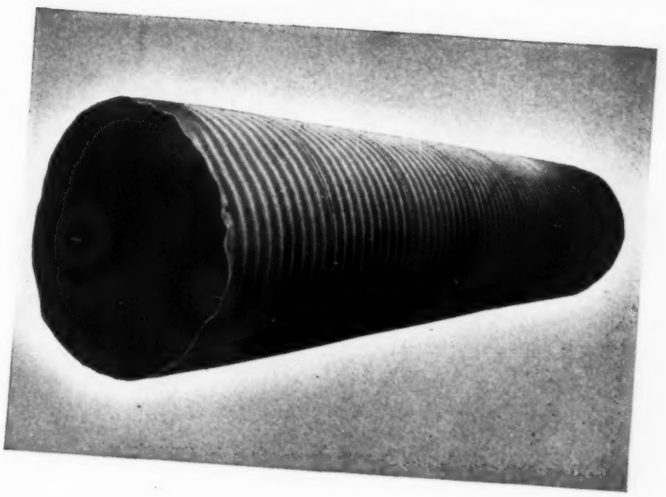
The first installation of sodium lights in the Northwest, where sixty-six 10,000-lumen General Electric units have been staggered 200 ft. apart along nearly three miles of four-lane Pacific highway, between Tacoma and Fort Lewis, Washington, is also the largest

Highway Illuminated with G-E Novalux Sodium Lamps and G-E Novalux Reflector Luminaires at Tacoma, Wash.

installation in the United States at the present time.

The East has the second largest installation. Fifty-four G-E units are in operation on the General Edwards bridge and its approaches at Lynn, Mass.

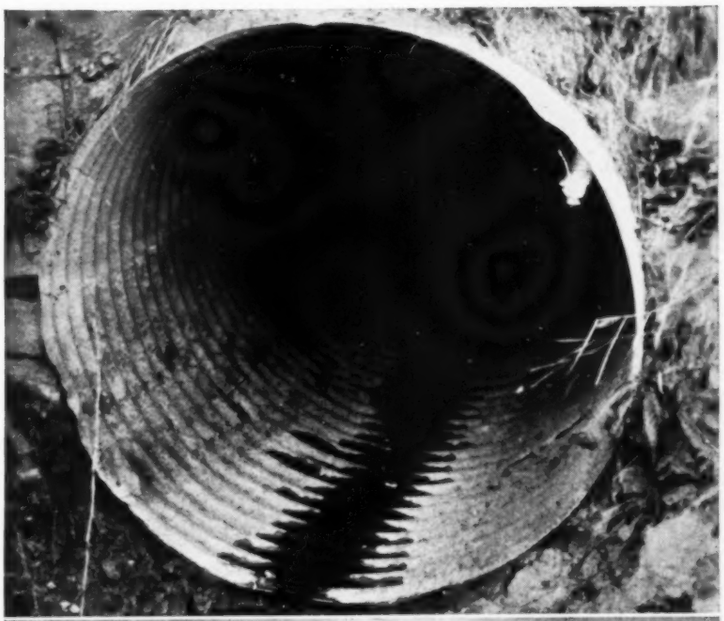
Since the American premiere of the sodium lamp in June, 1933, along a half-mile of the Balltown highway, near Schenectady, N. Y., General Electric luminaires have been installed in all sections of the country, in Hawaii, India, Spain, South Africa, Dutch East Indies, Brazil, and Canada.



Here's the first corrugated pipe—made and installed in 1896, near Crawfordsville, Ind.—removed for exhibition, after 28 years in the ground.

3 *Events*

THAT MADE DRAINAGE HISTORY



IN 1896: Many of the objections to existing types of drainage structures were eliminated by the invention of corrugated metal pipe. Its long, light-weight sections brought about immediate savings in hauling and installation costs. Moreover, due to its flexibility and sturdy joints, corrugated pipe soon proved its ability to stand up where other types couldn't take it. And it has continued to prove its superior strength *for 40 years!*

IN 1906: The development of rust-resisting ARMCO Ingot Iron created a high standard of durability for corrugated pipe. In fact, many of these pure iron drains are sound and strong today—after *30 years of service.*

IN 1926: ARMCO engineers raised the standard of corrugated pipe still higher, by putting a thick bituminous pavement in the bottom, where the wear comes. This improved product—known as ARMCO Paved Invert Pipe—gives you the 40-year strength of corrugated metal; the 30-year durability record of pure iron; plus an *extra 10 years* of service, already established by the protected bottom. No wonder more and more engineers and public officials are turning to ARMCO Paved Invert Pipe, for every drainage purpose. It costs less because it lasts longer. Make us prove it.

Above: **After 30 years of service, this ARMCO pure iron culvert is still functioning 100%.**

Below: **ARMCO Paved Invert Pipe—paved where the wear comes, with a special bituminous material.**

ARMCO CULVERT MANUFACTURERS ASSOCIATION • • • Middletown, Ohio

EDITORIALS

Continued Federal Aid Necessary

EVERYONE, except a few women in pants and a few men in panties who are advocating their own pet schemes, realizes that the ever-increasing use of the highways as a means of transportation necessitates the extension of present highway facilities and the modernization of many existing highways. In order to carry out this necessary work, there must be adequate funds. For many years the Federal Government has aided the states in their highway programs. This Federal Aid should be continued. A definite knowledge of the future availability of funds for a construction program is necessary for adequate advance planning. Without adequate advance planning it is impossible to maintain construction programs on an even keel or to avoid delays in undertaking such programs. Continuance of Federal Aid to the states gives assurance to the highway contractor that there will be opportunities for work for his outfit not only this year but for several years. And this means much to the highway equipment manufacturer.

▼

The Diesel Is Here

TWO impressive features of the recent A. R. B. A. road show at Cleveland were the large amount of heavy dirt moving equipment on exhibit and the surprising number of machines that were powered by diesel engines. Both these developments have taken place on an extensive scale since the previous real road show. Trucks, tractors, graders, power shovels and many other classes of equipment used in the highway field now have diesel power.

When the president of a company manufacturing diesel engines recently crossed the country in a car powered with one of his engines with a reported total fuel cost of less than $8.00 for 3774 miles he started something.

In fact one automobile manufacturer has already announced that he would use the diesel engine in a stock car, and there have been rumors that other automobile manufacturers would follow his example. Certainly much experimental work with that end in view is now under way in various plants throughout the country.

Already fuels, other than gasoline, are being used in such amounts in motor vehicles traveling the public highways as to lessen service fees derived by the states and used by them for the construction and maintenance of their highways. When it is considered that diesel fuel oil at present costs from 5 to 7c a gallon and gasoline from about 15 to 25c per gallon, and that about 50 per cent less of the former is required for a definite mileage, it will be seen that the state authorities soon will be confronted with a pretty problem in equitably taxing the new fuel to supply funds for their highway budgets. It is significant that the association of State Highway Officials already has taken action in this matter. At their 21st Annual Convention at Miami, Fla., last December, the Association adopted a resolution urgently requesting the respective state legislature to take such action as will properly and equitably tax all motor vehicle fuels.

It's Up to Construction

IT WAS stated recently that if the industrial group, classified as manufacturing and mechanical, was working at full capacity it could absorb only 2,000,000 or 3,000,000 of the unemployed. Of course, the other members of the industrial group, such as transportation, mining, trade, etc., could if working as in normal times furnish employment for many additional hundreds of thousands of those now without work. But there still would be several million men unemployed.

An estimate of the National Industrial Conference Board places the number of unemployed in December, 1935, at 9,895,000. The American Federation of Labor in a recent estimate placed the number at over 11,000,000. The Federation's estimates, however, always have been much higher than those from any other source.

Now, in 1928, the peak year of construction for the period 1925 to 1933, about $12,000,000,000 was expended for all construction purposes. While in 1933, the low year of the period, only about $3,000,000,000 was spent. It has been estimated that this drop in construction expenditures resulted in a decrease of 2,800,000 men in job employment, 3,800,000 in indirect employment, 200,000 in related producer goods employment and 3,800,000 in consumer goods employment. This makes a total of 10,600,000. In addition there might well be added 2,400,000 more whose jobs have been eliminated by changes in industrial processes.

These figures show the paramount importance of the construction industry in the economic life of this country. Were the whole industry as active as in years before the depression, the unemployment problem would largely be solved.

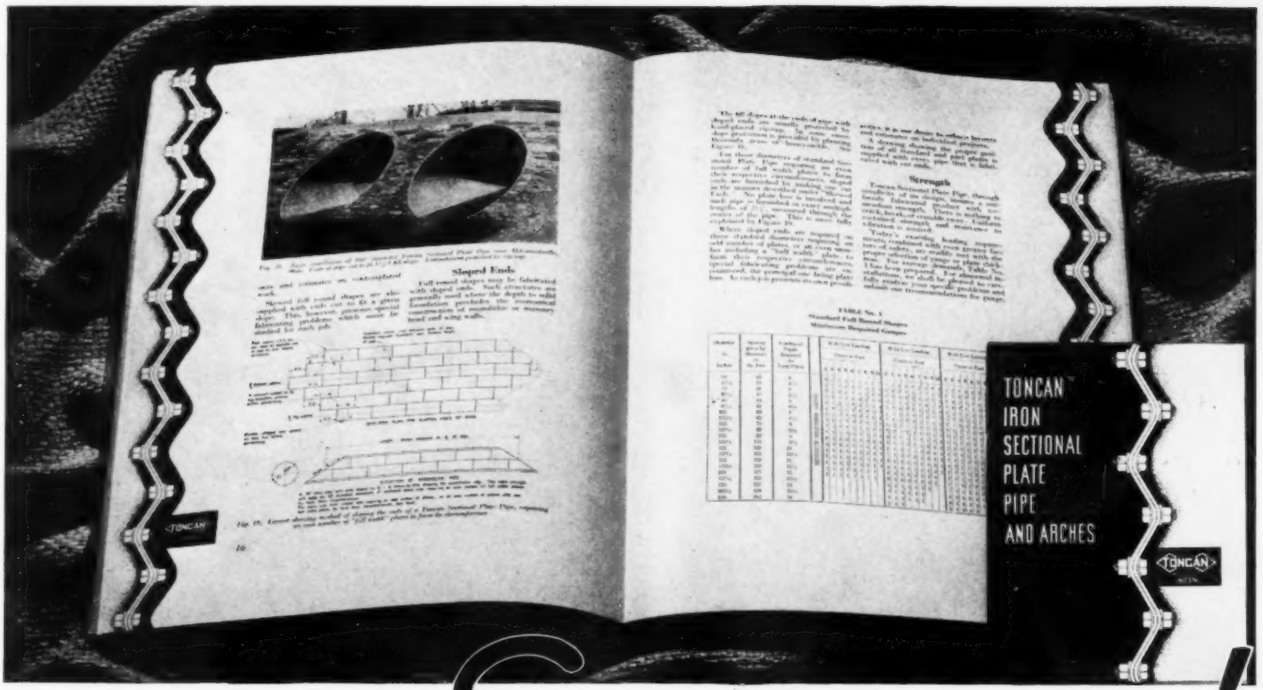
▼

Good Old Mississip'

THE New Orleans Times-Picayune of Jan. 28 contains a clever cartoon. Its title was "A Welcome Sign at the Old Cross-Roads," and it meant just exactly what it said as anyone who has driven across the state of Mississippi will agree. The cartoon depicted a gentleman from Mississippi standing at the intersection of four roads, one from the north, one from the south, one from the west and the other from the east. On each road was an automobile, the occupants of which were expressing their joy at the sign which the above mentioned gentleman had just nailed to a post. The sign was as follows: "$40,000,000 Mississippi Highway Paving Promised in Near Future."

This promise on the sign is to become a reality for on Jan. 30 the Governor of Mississippi signed the bill that makes possible a $42,000,000 construction program that will give the state a system of paved through trunk line highways within the next two years.

The legislative act under which this system will be constructed provides for a $24,000,000 issue of state bonds, of which $19,800,000 are to be disposed of through the Federal Public Works Administration. The balance of the state bonds, $4,200,000 is to be sold in a separate series and is to be used to match the regular Federal Aid. In addition the Federal Government is to make a grant of $15,000,000 WPA funds. As a result Mississippi this year will have one of the largest highway construction programs in the United States.



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NEW EQUIPMENT AND MATERIALS

"Caterpillar" Announces New Tractor Grader

The No. 22 tractor grader has been announced by Caterpillar Tractor Co. of Peoria, Ill.

The new product has an 8-ft. blade and weighs 3,575 lbs. It contains all of the design features offered in the four larger models, according to the manufacturer. Advantages include

Caterpillar No. 22 Tractor Grader

welded box frame construction, adjustable tractor pole, leaning wheels and an extensible lift link for extreme blade positions. Its flexibility makes it equally adaptable for construction, ditching and maintenance work.

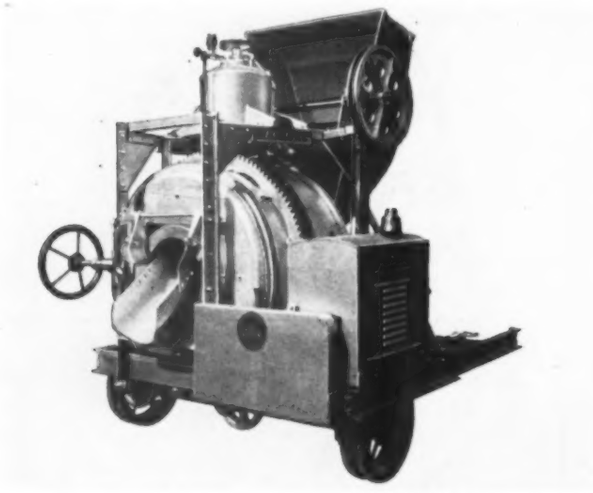
Built to match tractors between 20 and 35 hp., the No. 22 grader is expected to render a new service to road networks of townships and smaller cities.

▼

Ransome's New 7-S and 10-S Mixers

Among the recent developments of Ransome Concrete Machinery Co., Dunellen, N. J., are the two-wheel, trailer type, end discharge concrete mixers in the 7-S and 10-S sizes.

These new Trailer Type Mixers are typically "Ransome" in design, quality and workmanship, the same as the pavers and larger mixers built in various sizes up to 4½ cu. yd. batch capacity.



7-S and 10-S Ransome Two-Wheel Trailer Type End Discharge Concrete Mixer

These trailer type mixers are of light-weight but heavy-duty construction and are arranged on shock-absorbing springs with steel or rubber tired truck wheels equipped with roller bearings. Mixers are compact and well-balanced for towing and easy manoeuvring on job, permitting mixers to be located in limited spaces.

Other features and refinements in these new mixers are: positive water control with non-by-passing water valve; all steel drum with drum shell and mixing blades of high carbon wear resisting steel; solid steel roller tracks welded to drum and machined to true diameter; discharge chute also of high carbon wear resisting steel; each roller equipped with two Timken tapered bearings; speedy power loader skip of streamline design that elevates to a 50-degree angle, dumping its load into the drum fast and clean without any pounding; countershaft revolving in Hyatt bearings in self-aligning boxes. Operating levers arranged at one end for easy one-man control.

▼

Le Tourneau Announces Cradledump Buggy

The Cradledump Buggy, a new earthmoving carrier of 30-yd. capacity, built for use with large-size tractors, and without the front axle, for use with trucks as a semi-trailer, has just been announced by R. G. LE TOURNEAU, INC., of Peoria, Ill., and Stockton, Calif. The Hug Model 100 tractor truck has been developed to handle this new Le Tourneau Job. The combination of Cradledump trailer and tractor truck was specially designed by Le Tourneau and Hug for the use of contractors desiring a powerful, highspeed carrier for long hauls.

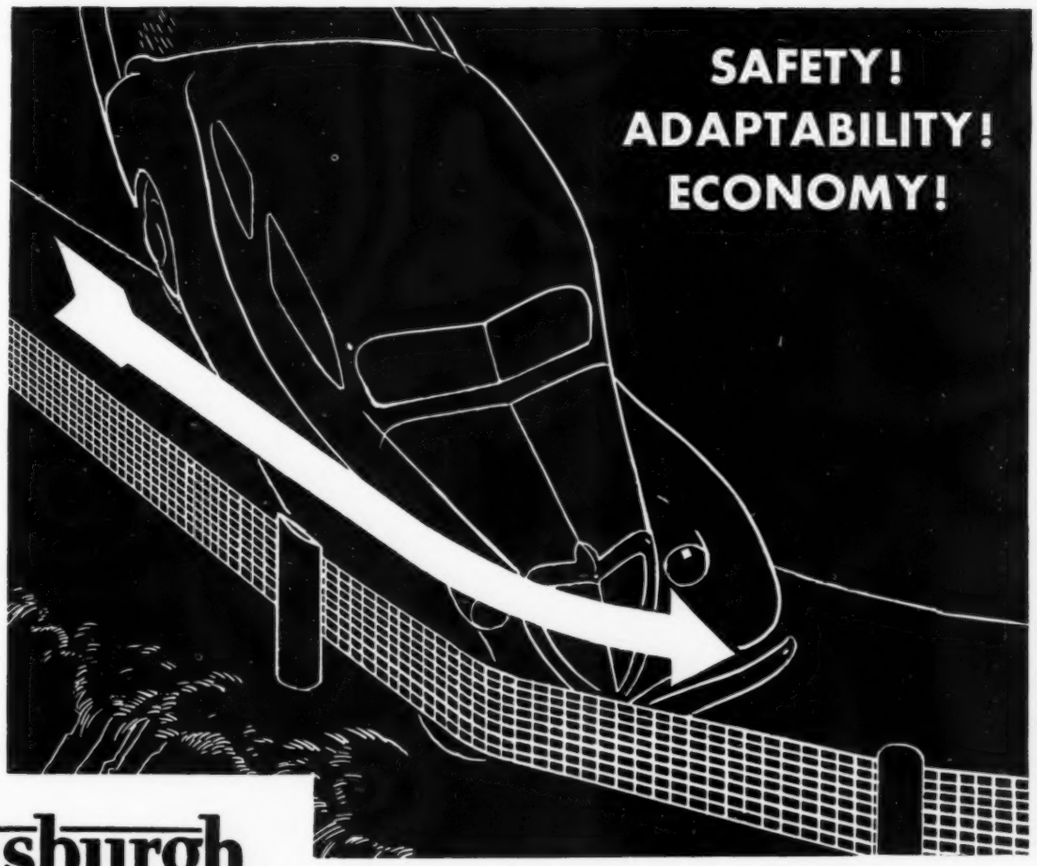
The Cradledump buggy has a water-level capacity of 30 cu. yds. and approximately 35 yds. loose measure. Its inside body dimensions are 9x13 ft. Unloading is controlled from the tractor driver's seat by means of ½ in. steel cables and sheaves con-

Le Tourneau Cradledump Buggy

nected to a standard two-drum power control unit mounted at the rear of the tractor motor. The body is pivoted at the top and expels its load by moving in a cradle-like arc to the side, forcing the entire load off the buggy as it moves. One line from the power control unit controls this dumping process, the other line returns the body to the loading position and holds it there.

Like all Le Tourneau equipment, the Le Tourneau cradledump buggy is stoutly constructed of special alloy steel, electrically arc welded. The body itself consists of four sides well-reinforced to prevent binding or twisting. The bottom is separate from the top and stationary. It serves the dual purpose of a base for the sides and a frame for the running gear and is ruggedly built to withstand the terrific shocks of loading earth and rock from shovels. It has a double bottom consisting of two layers of alloy steel with a 6-in. layer of wood in between. The two steel layers are tied together at 27-in. intervals by cross ribs of steel. A heavy, reinforced truss runs the full length of the bottom.

Both the cradledump buggy and Hug Model 100 tractor truck are mounted on 18.00x24 tires, with six tires on the truck and four on the cradledump trailer. This gives a ground contact for the combination of 6,000 sq. ins. When used with tractors the cradledump buggy is equipped with eight of these tires, mounted front and rear in dual sets.



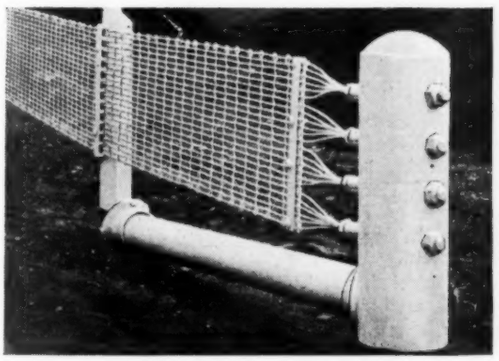
Pittsburgh *Safety* HIGHWAY GUARD

HERE'S A GUARD THAT CAN *take it*

Yes, Pittsburgh Safety Highway Guard can *take punishment.* In actual service it has never been broken through. In the most severe collisions, it repeatedly shows either no damage at all, or only minor damage which can be repaired by common labor on the spot at absurdly low cost. It rarely permits damage to posts. It reduces damages to car and personal injuries by cushioning the impact of the vehicle like a giant spring.

Pittsburgh Safety Highway Guard is, in fact, an elastic band of tightly interlaced heavy gauge semi-spring steel wire whose tensile strength and elasticity is furnished by 24 continuous line wires. The Guard is heavily white enameled for greater visibility.

The performance of this Guard under a wide diversity of actual service conditions has been checked in a recent survey by the Pittsburgh Testing Laboratory. A copy of the report of the investigators is available to highway officials on request. Write, giving your name, address and title.



PITTSBURGH STEEL COMPANY

742 UNION TRUST BLDG. • PITTSBURGH PA.

New York Chicago Detroit Memphis Houston St. Louis Syracuse Philadelphia San Francisco Los Angeles

Specifications for the Cradledump buggy are as follows:
Height of sides above ground, 9 ft. 9 ins.
Middle depth of body inside, 93 ins.
Width of body inside, 9 ft.
Length of body inside, 13 ft.
Length from pivot point on truck to rear axle, center to center, 23 ft. 6 in.
Struck measure capacity, 30 yds.
Tires, when used as a buggy, with tractors, eight 18.00x24 mounted in four dual sets.
Tires, when used as a trailer, with trucks, four 18.00x24 mounted in two dual sets.
Weight of Cradledump buggy, 25,800 lb.
Weight, when used as a trailer with trucks, 21,300 lb.

The Hug Model 100 tractor truck, which is built especially for use with the Cradledump buggy, has a 4-wheel drive and is powered by a Caterpillar Diesel Model D13000 engine. In tests this 4-four wheel drive has developed a remarkable amount of traction in soft mud. It is capable of a top speed of 29 miles per hour in overdrive and has a low speed of 1½ miles per hour. The drawbar pull at this lowest speed is 28,837 ft. pounds.

Both the Le Tourneau Cradledump buggy and the Hug Model 100 tractor truck will be displayed at the Road Show in Cleveland, January 20 to 24, according to the manufacturers.

▼

Koehring Tilting Mixer and Trail Dump

Koehring Company, Milwaukee, Wis., has maintained progress during 1935, through the development of new equipment, as well as improvements on the present machinery.

Outstanding among the developments is the 4-yard concentric zone tilting mixer developed for Grand Coulee. Eight of these machines will be pouring concrete for the dam construction. These mixers are charged and discharged through the same opening. The drums have only one opening, 38-in. diameter, thereby utilizing a greater portion of the drums for mixing.

The mixing position of the drum is 15° above horizontal and

Koehring T-7 Trail-Dump

the discharge position is 60° below horizontal. The cradle, drum and power unit are tilted as one unit which is suspended on pedestals on either side of the main frame. Tilting to the discharge position and return to mixing position is accomplished by means of two pneumatic air rams. The completion of each travel is air-cushioned. The drive is direct through enclosed reduction gear to the drum, thereby eliminating chain or belt drive and motor couplings. The design permits installation of batteries of 2, 3 or 4 mixers for charging from one proportioning plant.

This new type tilting mixer can also be had in the 2-yard size with the similar important features.

Koehring has made similar progress in the dirt-hauling field. The T-7 Trail-Dump has been added to the line of dirt-hauling equipment. This is a tractor type unit with a 7-yd. heap capacity wagon having a high travel speed of approximately 20 miles per hour. Important features are the "automatic hand" for closing the wagon doors, "non-raring" hitch, greater than 90° turning radius and mono-plate welded body construction. The "automatic hand" dumps the load instantly, and automatically closes, at the operator's will, the door as soon as the wagon pulls away from the load. All operation ceases as soon as the doors are closed.

The Koehring W55 Dumptor has been improved to give greater capacity, longer wheel base and further perfected balance and stability. It is now furnished with vacuum type booster brakes and lug type tractor tires for positive traction.

Improvements have also been made on the excavating equipment varying in size from ¾-yd. to 2-yd., as well as the mixer line, 3½-S to 112-S.

▼

FWD Features Safety in Its 1936 Line of Streamlined Trucks

The Four Wheel Drive Auto Co., Clintonville, Wis., has further stressed the automotive safety factor in its 1936 line of trucks. Along with safety, the FWD Company has combined beauty through the eye-pleasing lines of the streamlined fenders, hood and cab.

The safety features, which are engineered into the FWD truck include: The set-back front axle and powered front wheels

New FWD Truck

which make for positive steering through a more equal distribution of power and load. Rapid acceleration is provided by the extra-traction of four driving wheels and the high torque of the heavy duty motor.

Quick stopping in traffic, on the highway and emergency stops while upgrade are made possible by two sets of independent 4-wheel brakes. These are the hydraulic 4-wheel service brakes—booster-operated and the parking brake which acts on all 4 wheels through the driving mechanism. Use of alloy steels throughout plus the rugged construction of the entire chassis gives it the ability to withstand the strain of heavy loads.

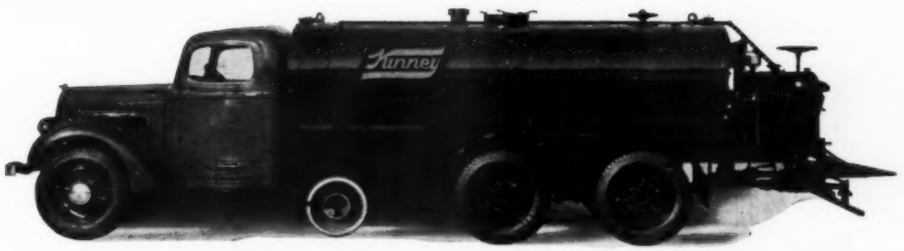
Driver comfort has been provided for in the construction of the FWD. The deeply upholstered seats and comfortably located controls in the streamlined cabs lessen driver fatigue. The positive steering and quick responding, booster-operated brakes give the driver a feeling of security.

In addition to the aforementioned safety features, the FWD Company has adopted a triple line of defense against carbon monoxide as a portion of the production process. The first defensive measure is the installation of gas tight cabs and a thorough check of each with a continuous carbon monoxide detector. Every precaution is taken to prevent carbon monoxide from entering the cab and endangering the lives of the truck operators. The second defensive measure is the use of 3-piece manifolds with expansion joints to assure tight exhaust lines. This lessens the chances for exhaust leaks through warped gaskets and cracked manifolds. Because the elimination of the cause for carbon monoxide is of prime importance, there is a third line of defense. This is the thorough check and adjustment of the ignition and carburetion systems of each truck in order to attain the proper combustion efficiency of the motor. This insures against an excess of carbon monoxide in the exhaust gases.

▼

Dodge Announces 1936 Trucks and Commercial Cars

Featuring "fore point" load distribution, hydraulic brakes, "preproved" economy, beauty in appearance and Amola steel springs, Dodge division of Chrysler Corporation announces a new series of trucks and commercial cars for 1936. This new line will consist of the following chassis models: One-half, three-quarters, one, one and one-half (in two series), two, three and four-ton models. Specially built custom Airflow models also will be offered.



More Important

than its good looks

is the way it does its job; the accuracy with which it measures bitumen onto the road; its uniform heating; the number of days it is working and not laid up for repairs; and its simple operation with one lever interlocking all necessary controls—spray valves, circulating valves, and air blowing.

Write for Bulletin A for full details.

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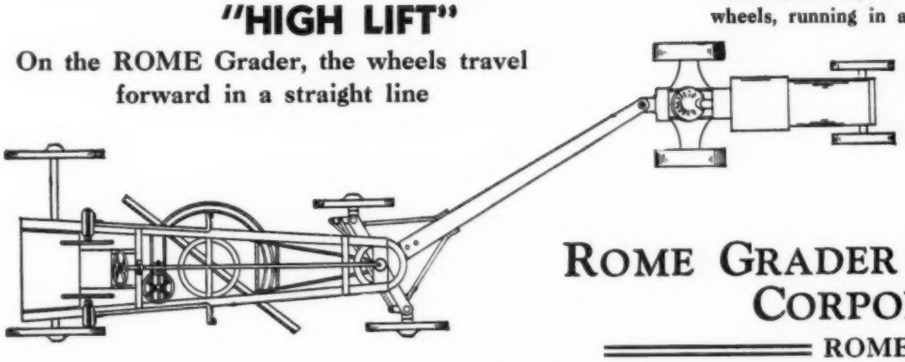
"HIGH LIFT"

On the ROME Grader, the wheels travel forward in a straight line



"The Best Bargain is Quality"

REGARDLESS of the position of the tractor, the ROME Grader travels in a straight line—follows the direction of draft without skidding. The pole is fastened to the fifth wheel directly in line with the draw-bars, is securely braced, and forms a unit with the fifth wheel and the front axle. The axle turns as the pole is turned. But the wheel spindles, operated by the steering gear, maintain their position at right angles with the grader. Thus the front wheels, traveling parallel with the frame, *do not skid sideways.* Moreover, the wheels, running in a straight line, give increased clearance between wheel and moldboard and prevent clogging. Pinching of spindles and consequent wear of wheel bearings is prevented on ROME Graders.

ROME GRADER & MACHINERY CORPORATION

ROME, N. Y.

Among the important innovations marking this new line of trucks is the "fore point" load distribution, through which the load is shifted forward in relation to the axles.

One of the major changes in the construction of the new models is the adoption of a strictly truck-type of frame on the ½-ton commercial car. This double drop frame is deeper in side rail cross section and has five truck-type cross members, including the rear engine support. The commercial sedan is an exception, in that Dodge uses its passenger car chassis to afford passenger car riding comfort for the commercial traveler and other large groups of users whose personal transportation needs also call for load capacity for the carrying of merchandise.

Emphasized for 1936 is "pre-proved" economy in both the operation and maintenance of Dodge commercial cars and trucks in which gasoline and oil economy play so vital a part. Outstanding fuel and oil economy have been developed through six major mechanical features and advantages. They are: Aluminum alloy pistons, four piston rings, full length water jackets, valve seat inserts, spray cooled exhaust valve seats and special oil cooling.

Amola steel, a recent metallurgical development of the Chrysler Corporation, which has high fatigue resisting qualities, is used in the springs of the entire 1936 line of trucks and furnishes an additional factor of safety.

A wide range of axle ratios, coupled with three, four and five speed transmissions, and several wheelbase lengths, permit these trucks to meet almost any transportation requirement.

▼

New Federal Truck

Announcement that a new Federal ¾-1 ton truck with 4-cylinder engine is now in production has just been made by the Federal Motor Truck Company, Detroit.

This new Federal is of all-truck construction, with every integral part designed and built specifically for truck service.

The four cylinder engine is mounted in rubber at three points, providing very smooth operation. The engine has a 3¾-in. bore, 4½-in. stroke, 198.8 cu. in. piston displacement and is rated at 50 hp. It has a three bearing crankshaft, shaft driven centrifugal water pump, force feed lubrication, valve seat inserts, helical timing gears, downdraft carburetor, air cleaner and fuel pump.

A great factor of safety has been built into the frame. It is of the pressed steel fish belly type with a maximum depth of 7-ins. The flanges measure 2⅞ in. and the stock on the 128-in. wheelbase length is 3/16 in. thick. For extra strength the frame stock on the 143-in. and 152-in. wheelbase lengths is 7/32 in. thick.

The front springs are 38-in. long by 2½-in. wide and the rear springs are 50 in. long by 2½ in. wide. Front springs are fore-shackled. Rear springs are fixed at the front end and rear ends float on frame brackets eliminating pins and shackles. All spring eyes and shackles are rubber bushed. No lubrication whatever is required at any of the connection points.

Front and rear axles are Timken. The rear axle is full floating bevel drive type. Like all other Federal trucks, the new Model 10 is equipped with Lockheed 4-wheel hydraulic brakes and cast brake drums. The front brakes are 14-in. in diameter by 1¾ in. wide, and the rear brakes are 15 in. in diameter by 2¼ in. wide.

Other chassis specifications include a 10-in. truck type single plate clutch, 4-speed transmission, roller bearing universal joints, 6.00/20 truck type balloon tires and cast wheels. Dual rear tires are furnished at extra cost.

▼

Motor Truck, Fitted With Power Take-off, Drives Arc Welding Generator

A power take-off developed by The Hercules Steel Products Co., Galion, O., in conjunction with The Lincoln Electric Co., Cleveland, O., is now available, by means of which an arc welding generator can be installed on any standard 1½-ton truck and driven direct from the truck motor.

The accompanying illustration shows a truck equipped with one of the units driving a Lincoln "Shield-Arc" welder.

This power take-off, which makes a truck a power plant as well as a means of transportation, is made in various models to operate as a direct drive or from the side. The unit is adaptable to all makes and models of trucks. It does not affect the road speed or power of the truck, since it simply replaces a portion of the truck's drive shaft.

Motor Truck Becomes Power Plant as Well as Means of Transportation. Fitted with Power Take-Off, Its Motor Drives an Arc Welding Generator.

Power supplied by any leading make of 1½-ton truck is sufficient to drive either a 200 ampere or a 300 ampere welding generator. Power take-off can be controlled from the driver's seat by a single lever. While welding, the speed of the truck motor is controlled by a fly-ball type mechanical governor.

Made of chrome-nickel alloy steel, this power take-off weighs 100 lbs. fully installed. All bearings are anti-friction ball and roller type. The unit is guaranteed to transmit 120 brake horsepower at 2800 revolutions per minute, 220 foot pounds torque.

▼

New Self-Priming Centrifugal Pump

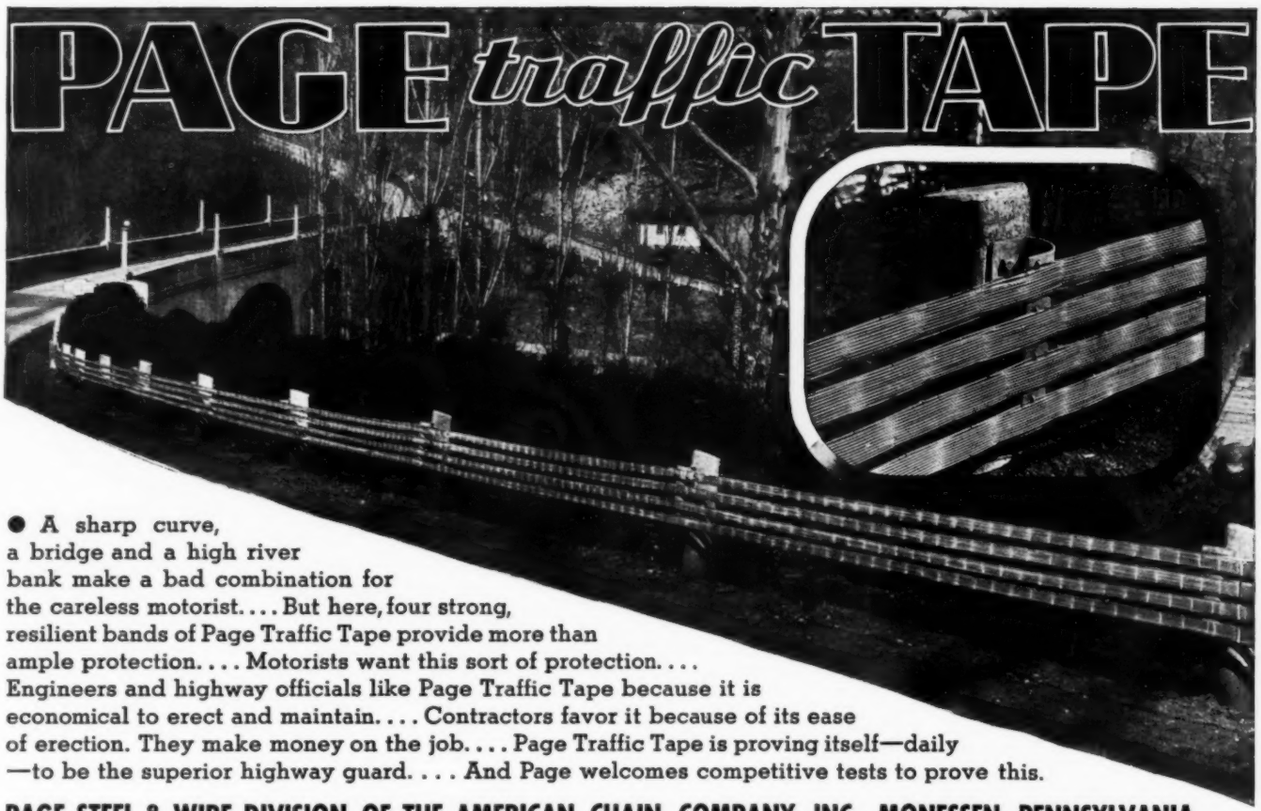
A new line of self-priming centrifugal pumps has been announced by the Novo Engine Co., Lansing, Mich. These pumps will be known as the Model V Self Primers. In the new design, simplicity and compactness are stressed.

The pump and engine are a unit assembly. The pump case is bolted directly to the engine block. This results in a very compact and economical design. Great care has been exercised in putting engines of ample horsepower on the various sizes so that the rated capacity will be delivered under all conditions. A new design of accurately balanced impellers has secured faster priming time.

The Model V Pumps will be built in five sizes. They are: 2 in. with 3 HP, single cylinder engine, 10,000 GHP; 3 in. with 5 HP, single cylinder engine, 18,000 GHP; 3 in. with 7 HP, 2

New Model V Novo Self-Priming Centrifugal Pump

PAGE *traffic* TAPE



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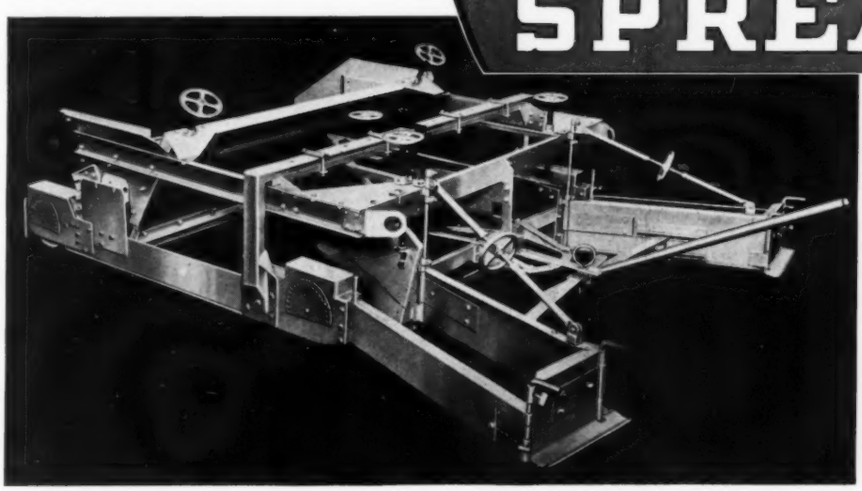
NEW ECONOMY *in Spreading and Finishing!!*

With the

Know More About This Simple, Low Cost Road Building Unit . . .

BLAW-KNOX Road FINISH SPREADER



The Blaw-Knox ROAD FINISH-SPREADER will spread and finish stone or gravel; hot or cold asphalt—one to fifteen feet wide—half a road at a time. Will lay varying widths on curves fully or partially banked—*with one machine at a fraction of the usual cost.*

Ask Blaw-Knox to send you Catalog No. 1523—"The Blaw-Knox Road Finish-Spreader."

BLAW-KNOX COMPANY

2003 Farmers Bank Bldg., Pittsburgh, Pa.

Offices and Representatives in Principal Cities

cylinder engine, 24,000 GHP; 4 in. with 9 HP., 2 cylinder engine, 30,000 GHP; 4 in. with 15 HP, 4 cylinder engine, 36,000 GHP; All of the above ratings are taken at a 10 ft. total head.

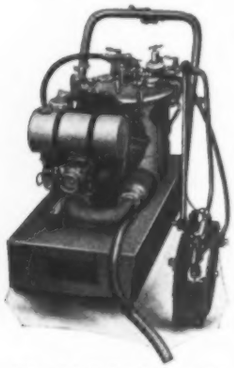
All power units are water cooled and all pumps are equipped with a suction strainer. All engines above the 3 HP. are radiator cooled with engine house and are provided with a throttle control.

The compact design has resulted in smaller overall dimensions and a considerable reduction in price.

▼

New Traffic Line Painting Machine

A new traffic line painting machine has been evolved by Littleford Bros., of Cincinnati, O. The machine consists of a DeVilbiss trigger operated hand spray gun, a motor compressor unit and a DeVilbiss paint container ingeniously mounted on a streamlined running gear having three pneumatic tired wheels. Machine is short coupled so that it will readily paint curves as well as straight lines.



The Littleford Traf-O-Spray

As a traffic line marker, it is claimed it will put down an even, clean cut line on any solid surface, whether rough or smooth, using any standard traffic paint, lacquer or even emulsion. No edge bleeding or slopping is experienced. No hand retouching is required with this machine.

The gun requires about ten seconds to be removed from spray head. As a hand paint spray outfit, the machine can be used for any kind of painting or spraying job.

Complete detailed literature and prices are available by addressing Littleford Bros., 454 E. Pearl St., Cincinnati, O.

▼

New Portable Gravel-Clay Stabilizer Plant

A portable plant for mixing the material for a stabilized gravel-clay wearing course has been brought out by the Pioneer Gravel Equipment Mfg. Co., 1515 Central Ave., Minneapolis, Minn. The stabilizer plant is a one-unit outfit and, except for the conveyors, is mounted on a four-wheeled all-steel truck. The plant consists of a clay feeder, belt conveyor, clay shredder, roll crusher if necessary, pugmill, calcium chloride hopper and feeder, and a delivery conveyor. The gravel is crushed and screened in a separate plant.

The crushed gravel is delivered directly into the pugmill. The clay is dumped through a trap onto a special type feeder which governs the amount of clay fed to the plant. A belt conveyor delivers the clay to a shredder which tears up the chunks. A roll crusher can be provided if necessary to crush rocks and flatten out the clay. The clay is then dropped into the pugmill with the gravel.

Calcium chloride is fed from a hopper on top of the plant through an automatic, adjustable feeder which controls the amount of calcium chloride.

Water is added as may be necessary in order to get the desired moisture content.

The pugmill thoroughly mixes and blends the ingredients and deposits the stabilized gravel on a belt conveyor for delivery to trucks or bins.

The mixed material can then be delivered directly onto the prepared grade and requires only spreading and rolling in order to make a finished stabilized wearing course.

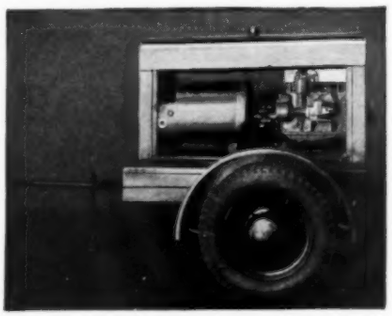
The Pioneer Portable Plant for Stabilized Road Construction.

▼

New General Utility Welder

An entirely new P&H-Hansen arc welder of 150-ampere capacity, announced by the Harnischfeger Corporation of Milwaukee, Wis., is claimed to have an unusually high electrical efficiency developed with the small air cooled gasoline engine which powers it.

Known as the Model W-150, this new welder, designed to cover a broader range of welding jobs, uses bare or coated electrodes from 3/32-in. to 3/16-in. for welding materials of varying thicknesses. Welding is simplified through single current control accomplished by shifting brush holders for current settings over the entire welding range.



New P&H-Hansen Arc Welder.

For field service, the standard unit can be mounted on a 2-wheel highway trailer to travel safely behind an automobile or truck at average motor car speeds. The trailer has sturdy, all-welded construction with engine and generator protected from road shock by automotive-type cantilever springs and balloon tires. Large tool boxes are mounted on each side of the welder for convenience in carrying equipment and accessories. Motor and generator are mounted on a single steel bed plate for minimum vibration and proper permanent alignment. The W-150 is also available on small 4-wheel industrial truck or for factory use with skid mounting.

Electric motor equipped models, either stationary or portable, are driven through a V-belt drive either stationary or on 2-wheel truck. Gasoline motro equipped units are driven direct-connected at 2,200 r.p.m., mounted on steel base. The generator is of standard P&H-Hansen design with patented internal stabilizer winding which provides unusually high arc efficiency without the use of external resistors, reactors or separate stabilizers.

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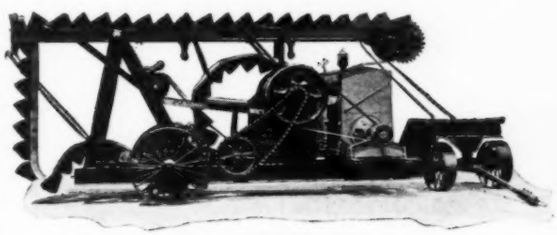
Portable or semi-portable and arranged to suit your requirements in sizing and capacity.



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Equipment for Quarry—Gravel and Sand Pits

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BLAW-KNOX

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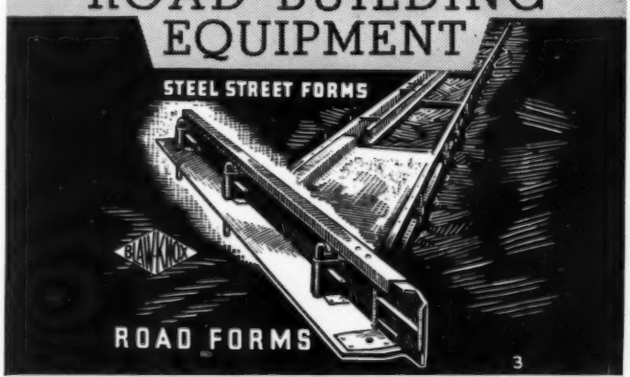

New developments and improvements in Blaw-Knox Construction Equipment are right in step with today's program.

With a background of years of practical experience, Blaw-Knox equipment is trustworthy. It is economical and low in maintenance. Designed to stand up under severe operating conditions, it is fitted to the job by skilled engineers. It helps immeasurably to fulfill contracts speedily and profitably.

BLAW-KNOX COMPANY, 2003 Farmers Bank Building, Pittsburgh, Pa.
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BLAW-KNOX ROAD BUILDING EQUIPMENT
Includes:—
BATCHERPLANTS • ROAD FINISH-SPREADERS (Manuel or Automatic) • TRUKMIXERS
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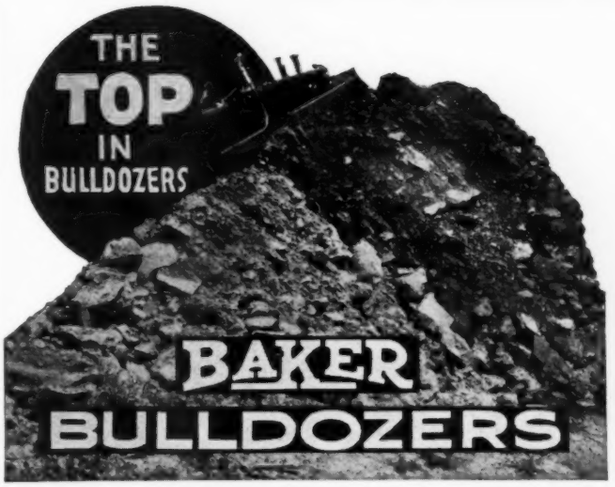
ROAD FINISHERS • CLAMSHELL BUCKETS • (Gas-Electric) • CONCRETE BUCKETS
CEMENTANKS • STEEL BUILDINGS • STEEL GRATING
Literature on any of the above BLAW-KNOX Products will be sent upon application.



Start at the top when you are selecting Bulldozers for your job. Baker Direct Lift, Twin-Cylinder Bulldozers are built to meet your needs—"plenty tough" on the hard jobs, yet accurate in performance and easy to handle.

You save money, too, on your repair bills because Baker Bulldozers are direct-lift, eliminating gears, levers and cranks. Correct mounting saves wear and tear on your tractor.

That's why leading contractors are using Bakers on the big construction projects throughout the country.

They give you a new idea of what Bulldozer performance really is

Ask for Bulletins on Bulldozers and Other Baker Equipment.

BAKER TRACTOR EQUIPMENT
EARTH MOVING-ROAD MAINTENANCE-SNOW REMOVAL

THE BAKER MFG. CO.
506 Stanford Ave.,
SPRINGFIELD, ILL.

Bulldozers, Scrapers, Road Discs, Gradebuilders, Road Rooters, Snow Plows.

Vibrator Spades

Vibrator spades, operated by compressed air have been placed on the market by the New Haven Vibrating Co., New Haven, Conn. Two types are made. Type 1455-A was especially designed for use between reinforcing and the inside face of the form. The blades are 12 in. long and 4 in. wide. Type 1455-B has a supplementary blade 24 in. long and 4 in. wide, corrugated, and is used as an attachment to the standard type 1455-A to produce a smooth, voidless surface, eliminating patching and finishing.

This unit operates in a horizontal position and may be operated at as low a pressure as 20 to 30 lb., depending upon the slump.

The vibration blades are spaced that 3 in. aggregate is easily cleared by the three spade blades that are a part of a removable housing bolted through on to the vibrator unit. The housing is renewable when worn and a new set easily bolted (four bolts) to the vibrator unit which is an integral unit complete in itself, the housing being merely a wearing piece.

Type 1455-A Vibrator

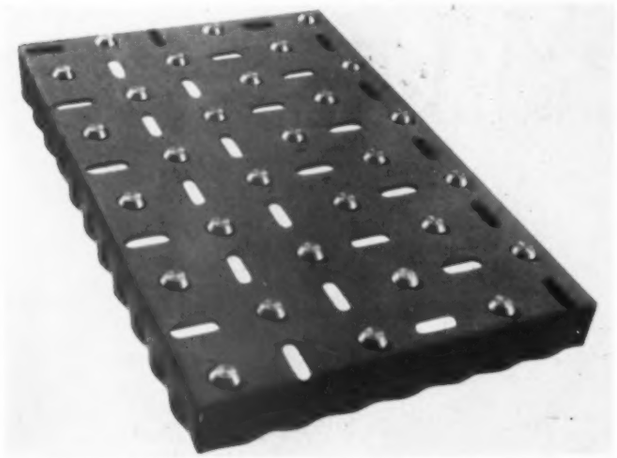
Frequency is easily controlled by the valve and ranges from an idling speed of a few hundred strokes per minute up to a maximum frequency of approximately 7500 blows per minute. A flexible connection just above the vibrating unit eliminates shock to the operating handle.

▼

New Steel Paving Plates

Bethlehem Steel Company, Bethlehem, Pa., has just placed on the market a new type of permanent and protective surfacing for concrete floors and paving, designated Bethlehem steel paving plates which are designed for installation on the surface of concrete slabs to which they are anchored and with which they become, in effect, an integral part.

These Bethlehem steel paving plates are of ⅛-in. rolled steel, and are available in two sizes. One is intended for use on roadways; the other for plant floors, loading platforms, and docks. Both types are identical, except that the one for roadways is equipped with button-head studs, making it a non-skid plate. As shown in the accompanying illustration, the sides are perpendicular to the surface, and are so crimped as to give the plates firm anchorage in the concrete. Additional anchorage is provided by studs which extend into the concrete. And, when these plates are laid the fresh concrete fills the slots to the top of the plate, providing additional bond between concrete and plate, and at the same time, increasing its non-skid surface.



In the Road-Type of Bethlehem Steel Paving Plate, Anti-Skid Buttons, of Wear-Resisting Steel, Are Welded in the Holes. Through the Holes Not Having Buttons, Long-Shank Anchor Studs are Inserted, and Pushed Into the Fresh Concrete After the Plate is Laid.

The floor-type Bethlehem steel paving plate has a smooth surface, the long-shank anchorage studs, with flat heads, fastening through countersunk holes, making them flush with the top surface of the plate.

The anti-skid or road-type plate is applicable to thoroughfares, such as tunnels and bridges, that carry extremely heavy, continuous traffic.

The floor-type Bethlehem steel paving plates find application in warehouses, breweries, docks and loading platforms where heavy goods are ordinarily conveyed on trucks with steel wheels of small diameter and small flange width, which are very hard on floor surfaces. Like the road plates, Bethlehem steel paving plates of the floor type are anchored securely to the concrete slab and become, in effect, an integral part of it. They are built to stand up through unusually long periods of severe service. The standard size of these Bethlehem paving plates is 12 in. by 18 in., with 1½ in. sides.

▼

Concrete Grinder

A machine that is claimed to level concrete road surfaces within ⅛ in. in every 10 ft. is a product of the American Floor Surfacing Machine Co., Toledo, O. In this machine the cutter head rotates at a high speed and the cutters do their work at a rapid rate which is accomplished by placing the cutters around the outer rim of the drum type cutter head. The rotary action of the cutter head placed on a horizontal axis gives a smooth, keen cutting action. The cutter head is made of two heavy sections of steel arranged so that a new set of cutters can easily be assembled in place. The cutters are made of hardened, high grade steel and are of the star wheel type, 72 being used in each assembley.

American Concrete Grinder on Job.

The machine is powered by a 5 HP. high speed single cylinder air cooled gas engine and is mounted on rubber tired wheels. Its length is 7 ft., width 2 ft., and height 2 ft. Its net weight is 650 lb.

▼

New Oil-Resisting Pneumatic Hose

A new air hose, designed especially to overcome the deteriorating effects of hot oil from air compressors, is announced by The Republic Rubber Co., Youngstown, O. The tube is made from a compound similar to that used in oil conducting hose and can actually be saturated with oil for long periods of time without affecting its serviceability.

In addition, the hose has great resistance to heat, high pressures, abrasion, the cutting effect of sharp rock and exposure to sun and weather. The manufacturers recommend it for mines, quarries, rock industries, road work, contracting and general industrial use where service is exceptionally severe.

Great strength has been obtained, without impairing flexibility, by constructing the plies from a specially twisted cord which is thoroughly impregnated with a new tenacious rubber compound. This also increases the bursting and working pressures, and results in greater resistance to shock and abuse.

Pierce Power Rollers

For Road and Street Construction and Repairs

For building and maintaining roads and streets, Pierce Rollers are without an equal. The first cost of the Rollers is low and cost of operating is negligible. Because of weight distribution and roller width, the compression per inch compares favorably with that of heavier rollers. Many Pierce Rollers have been in service eight and nine years without any parts replacements and practically no service expense.

Built in three serviceable models—¾-ton, 1½-2 tons, and 3 tons. You save money when you buy Pierce Rollers. Write for information.

The Pierce Governor Company
Anderson, Indiana

The Sure Foundation for All Portable Equipment

ELECTRIC STEEL WHEELS

The experience accumulated in the designing and making of many millions of wheels for American industry is available to equipment manufacturers. Their wheel problems are welcomed by our engineers whose close cooperation is devoted to attaining the highest wheel efficiency under any operating condition.

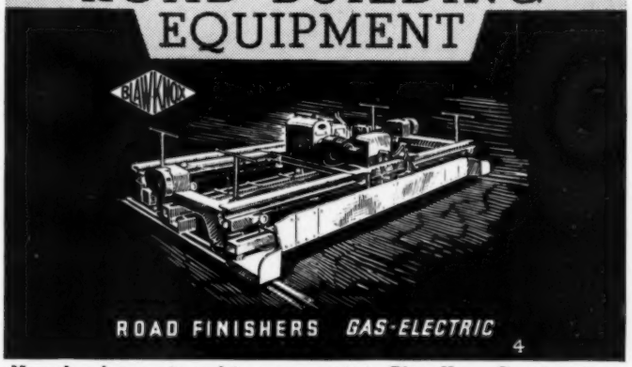
Ask for Bulletin 250 and 265

ELECTRIC WHEEL CO.
DEPT. RS QUINCY, ILLINOIS

ELECTRIC STEEL WHEELS

BLAW-KNOX

ROAD BUILDING EQUIPMENT



New developments and improvements in Blaw-Knox Construction Equipment are right in step with today's program.

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Literature on any of the above BLAW-KNOX Products will be sent upon application.

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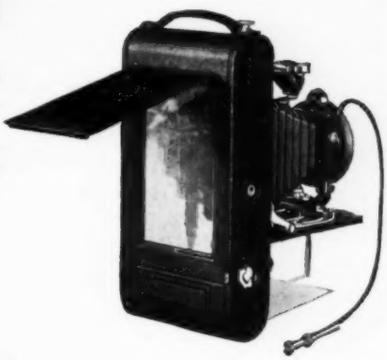


PAL KO, Inc. 311 N. Des Plaines Street, Dept. RS, **CHICAGO, ILL.**

WITH THE MANUFACTURERS

C. H. & E. in New Plant

The C. H. & E. Manufacturing Co., Inc., Milwaukee, Wis., has moved into its new plant at 3849 North Palmer St., in the new manufacturing district on the north side of Milwaukee. C. H. & E. has built a completely new and modern plant with the entire shop on one floor and offices on the second floor. With the new manufacturing facilities as well as the new up to date machinery, C. H. & E. will be able to maintain the high quality of its many new models and products at a lower cost to the consumer.

▼

Penn Sells Large Order for Clamshell Buckets

H. O. Penn Machinery Company, dealers in construction and industrial equipment in New York City, have recently sold what is believed to be the largest order for clamshell buckets on record in the New York territory. They have just delivered to the Gallow Trucking Company of New York 20 1½-yard Kiesler buckets.

▼

Butler Bin Holds Open House

Preceding the road show at Cleveland, O., the Butler Bin Co., Waukesha, Wis., manufacturers of steel bins and batching equipment, held an open house Jan. 15 for distributors and salesmen on their way to the road show. Approximately 50 guests visited the plant and attended an all-day sales meeting. Following a buffet luncheon at noon Morgan Butler, President of the company, explained sales plans for 1936 and introduced new developments in equipment. An exhibit of the new equipment, set up in the shop, was in operation for the visitors. The factory was host at a dinner in the Avalon Hotel, Waukesha, following the afternoon session.

▼

Convention of Technical Section, Explosive Department of du Pont

The 19th Convention of the Technical Section, Explosives Department, E. I. du Pont de Nemours & Company, was held at Wilmington, Del., Jan. 14, 15 and 16. Arthur La Motte, Manager of the section, presided.

Addresses were made by Lammot du Pont, President of the du Pont Company; J. Thompson Brown, a Vice-President; E. B. Yancey, General Manager; and P. J. Kimball, Director of Sales, Explosives Department.

Nearly 300 problems relating to commercial explosives and their uses, blasting accessories and other topics were discussed by the 130 du Pont men in attendance. Particular attention was given a wide range of applications of explosives to mining, quarrying, and highway and other construction. Those present included executives of the Explosives Department, the staff of the home offices of the Technical Section, technical field men from all parts of the country, plant managers and explosives' chemists.

▼

Koehring Appoints New Distributors

Koehring Co., Milwaukee, Wis., has made several appointments of new distributors for the sale of their products, including shovels, cranes, draglines, pavers, mixers, mud-jacks and dumptors.

Howard W. Read Corporation located at 800 North Delaware Ave., Philadelphia, Pa., will have the eastern Pennsylvania territory.

The northern section of Mississippi will be handled by the Dalrymple Equipment Co., Amory, Miss.

Massachusetts, with the exception of a few western counties, Vermont, Maine, and New Hampshire, have been assigned to the Parker, Danner Company, 4 Northampton St., Boston, Mass.

▼

Le Tourneau Doubles Factory Space

Construction work on a second large plant at Peoria, Ill., for R. G. Le Tourneau, Inc., manufacturers of heavy grading equipment, is now in progress. "Production has been carried on at so rapid a pace to accommodate the steady flow or orders that more assembling space is needed," says J. W. Le Tourneau, vice president and general manager.

This new addition, which will adjoin the original building, is to be constructed of brick and steel and will be 300 ft. long by 140 ft. wide with a 20-yd. wing on each side. It will have a floor space of 42,300 sq. ft. as compared with 30,000 sq. ft. in the present plant.

Le Tourneau's first Peoria factory was built early this Spring and had been in operation only a short time before a night shift had to be added to handle the company's increasing Eastern and Middle Western business. Even with the plant working full crews night and day, Mr. Le Tourneau reports the company is behind in filling orders.

The Le Tourneau Co. began its manufacturing operations at Stockton, Calif., and still maintains a complete production and assembly plant there to supply the needs of the eleven Western states.

▼

Ditwiler Manufacturing Company Changes Name

Mr. E. P. Monroe, secretary of the Ditwiler Manufacturing Co. of Galion, O., announces that their company will in the future be known as the Hercules Steel Products Co.

"The change in name of our company," says Mr. Monroe, "is made to more clearly associate our firm name with the name of our products."

For years the old Ditwiler Company has manufactured Hercules steel dump bodies and hoists and the use of the firm name "Ditwiler" has caused some confusion.

There will be no change in capital, management or facilities, according to Mr. Monroe, who also pointed out that there is no connection between their company and any other company.

The Hercules Steel Products include hoists of all types, dump bodies, special steel bodies, split drive power take-offs, chip and stone spreaders, Redi-Service bodies and other miscellaneous items.

It is the plan of the Hercules Company to add additional items to round out the line.

Distributors and dealers, as in the past will be able to secure Hercules Hoists and Bodies from Galion, O., or through their national distributors, Hercules Body Company in Evansville, Ind.

▼

Allis-Chalmers Advances McGraw

Allis-Chalmers announces the appointment of A. F. McGraw to the position of Sales Promotion Manager of the Tractor Division at Milwaukee.

A. F. McGraw

For the past four years Mr. McGraw has served the company as Industrial Sales Manager under O. J. Thomas at the Kansas City Branch. He also enjoys a wide acquaintance among farm equipment men by reason of his prior connection, both at Kansas City and Wichita, with the Avery Power Machinery Company and its Predecessor, the Avery Company, of Peoria, Ill.

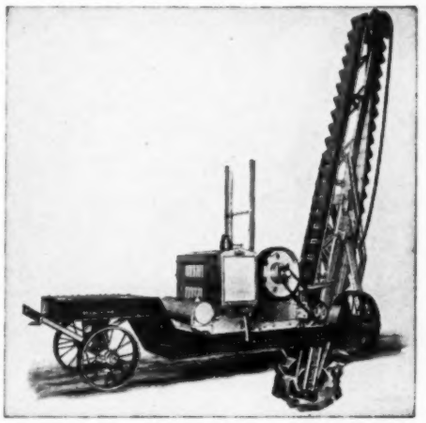
In his new capacity, Mr. McGraw will direct the sales promotional activities of the Tractor Division in both the Industrial and the Agricultural Departments, and brings with him a wealth of practical experience and knowledge of the business that should prove a valuable asset to him in his new work.

▼

Inland to Install Four New Open Hearth Steel Furnaces

Inland Steel Co., Chicago, Ill., has announced a construction program which involves the installation of four new open hearth steel furnaces. A contract for the fabrication and erection of the steel for the building which will house these furnaces has been placed with several Milwaukee, Wis., fabricators. The proper corollary equipment will also be installed, including a blooming mill, contract for which has been placed with the Mesta Machine Company of Pittsburgh, Pa. The new furnaces and mill will replace older equipment which has become obsolete.

GRUENDLER CRUSHER & SCREENING UNITS FOR THE ROAD JOB



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Portable, semi-portable and stationary units for crushing, screening and conveying in capacities from 100 to 4,000 tons daily. One reduction operations.

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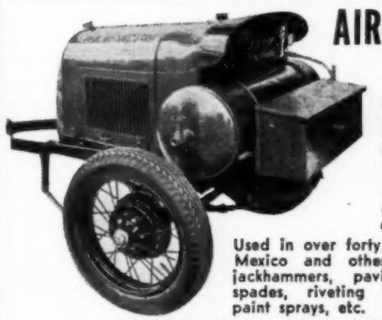

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FROM FORD PARTS

The patented Smith Compressor Head converts a Model A or B Ford Motor into a two-cylinder compressor with two power cylinders. Head is equipped with high-speed compressor valves for efficient operation. Over 60 cubic feet capacity.

Used in over forty states, Alaska, Canada, Mexico and other countries to operate jackhammers, paving breakers, tampers, spades, riveting hammers, sand blasts, paint sprays, etc.

Buy the complete machine or build it yourself.
Write for complete information and prices.

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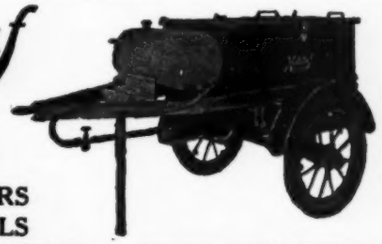

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POURING POTS, ASPHALT SPRAY PUMPS

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"DEAERATED CONCRETE"

The FLEX-PLANE Finishing Machine with wide screed effects a vacuum underneath. This vacuum is broken at intervals by momentary slight raising of the screed. This action pumps air and water from the concrete, giving greater strength and permanence.

FLEXIBLE ROAD JOINT MACHINE CO.
WARREN, OHIO

RELIANCE CRUSHING SCREENING and WASHING EQUIPMENT

Backed by 30 Years of Experience

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Complete Portable and Stationary Plants
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UNIVERSAL ROAD MACHINERY CO.
KINGSTON, N. Y.
New York Office—114 Liberty Street

Republic Steel Removes General Offices to Cleveland, O.

The general offices of Republic Steel Corporation have been removed from Youngstown, O., to Cleveland, O. The offices will occupy floors 13 to 16, inclusive, in the former Medical Arts Bldg., recently renamed the Republic Bldg.

The move consolidates the general offices which have been located in Youngstown, the executive and Cleveland district sales offices formerly in the Union Trust Bldg., Cleveland, and the Advertising Dept., Massillon, O. The sales offices of the Newton Steel Co. will also be located in the Republic Bldg., Cleveland.

The departments affected by the move include: General Operating, General Sales, Treasury, Purchasing, Accounting, Credit, Claims, Ordering, Coding, Traffic, Patent, Advertising and Sales Promotion, Sheet and Strip Sales, Pipe Sales, Bar Sales, Tin Plate Sales, Railroad Sales, Culvert Sales, Pig Iron and By-Product Sales, Engineering, Industrial Engineering, Salvage and Reclamation, and Industrial Relations.

The sales offices of the Alloy Steel Division of Republic will remain in Massillon, O.

▼

Kinney Transfers Office to Dallas, Tex.

The Kinney Manufacturing Co. of Boston has closed its office in the Finance Bldg., Kansas City, Mo., transferring this office to 710 Santa Fe Bldg., Dallas, Texas. This office, like the former Kansas City one, will be under the management of H. G. Saunders, who will be in charge of Kinney sales for distributors, pumps, and clutches for the states of Louisiana, Texas, Arkansas, Oklahoma, Missouri, Kansas, Colorado, Nebraska, and New Mexico.

▼

William J. Fitzgerald with Joseph T. Ryerson & Son, Inc.

William J. Fitzgerald, long identified with the construction and building industry in Minneapolis and the northwest, has joined the Ryerson organization. He will be located at Minneapolis and will cover Minnesota, North Dakota, South Dakota and Montana in the interests of their reinforcing, fabricating and building products division. Mr. Fitzgerald was formerly with the Paper Calmenson Company of St. Paul and prior to that eight years with the Truscon Company.

▼

Harry LeVan Horning Dies

Harry LeVan Horning, founder and president of the Waukesha Motor Co., died at Battle Creek Sanitarium, Jan. 4th. He was 55 years old. In April, 1906, in company with local business associates, he organized the Waukesha Motor Co., and became its chief engineer and general manager. Even as the business grew from a mere handful to its present size with 1200 employes, he never ceased to be the general manager. His intimate, close association with the company he founded was his one passionate interest in spite of numerous activities which claimed his time and attention outside. Mr. Horning is survived by his wife, Elsie, and his sister, Miss Mittie Horning, both of Waukesha, Wis.

▼

Willett to Manufacture Equipment at Plymouth, Ind.

The Willett Manufacturing Corporation announces the purchase of the assets and property of the Lee Trailer & Body Co. of Plymouth, Ind., and will manufacture road machinery, truck scrapers, snow plows, blades, sweepers, dump bodies, and semi-trailers, in the plant located at Plymouth, Ind.

▼

NEW LITERATURE

Industrial Lubrication Reference Manual by Alemite. This entirely new and unusual book contains a store of vital information for efficient lubrication maintenance of machinery. Lubricant recommendations for all types of industrial plans are given, classified according to types of machinery and according to types of gears and bearings. Editorial content includes such articles as "Common Causes of Bearing Failures," "Lubrication of Anti-Friction Bearings," "Grooving of Bearings," "Gears and Their Lubrication," etc. Illustrated with photographs and diagrams. All Alemite industrial lubricants fully described. A letter or postcard to Alemite, 1878 Diversey Parkway, Chicago, brings a copy.

Materials Handling Equipment Parts. This Catalog 417 (400 pages), of the Jeffrey Manufacturing Co., Columbus, O., covers chains, sprockets, transmission machinery; spiral conveyor, elevator and conveyor parts, along with all other Jeffery materials handling equipment parts. Gives specifications and list prices; presents pictorially line of materials handling equipment engineered, manufactured and erected by the Jeffrey company.

New Rock Drill. Sullivan Machinery Co., 307 North Michigan Ave., Chicago, Ill., has issued new bulletin entitled "Going Places." This bulletin describes Sullivan's New L-2 45-lb. rock drill and its advantages. Bulletin will be sent on request.

Properties of Toncan Iron. A new edition of the 12-page folder which contains a large fund of condensed, up-to-date information on rust-resisting Toncan copper molybdenum iron, has been issued by the Republican Steel Corporation, Youngstown, O. Two particularly important sections give complete physical properties and physical constants of this corrosion-resisting alloy iron. Copies will be supplied upon request to the Advertising Department, Republic Steel Corp., Massillon, Oh.

A Manual of Concrete Curing. The Columbia Alkali Corporation, Barberton O., will be glad to furnish to anyone interested the up-to-date "Columbia Manual of Concrete Curing" containing many charts, tables and useful information with reference to calcium chloride as used in the curing of portland cements and concretes. You may secure a copy for your use by mentioning ROADS & STREETS in writing to The Columbia Alkali Corporation.

Material Handling Equipment. Diamond Iron Works, 22nd and 18th Sts., Minneapolis, Minn., has published a new catalog of 328 pages on material handling equipment and transmission machinery and will be glad to send it to anyone interested on request. Ask for Catalog No. 35.

"Caterpillar" Diesel Electric Generators. Three sizes of Diesel electriuc direct-connected generator sets are illustrated and described in a new booklet recently released by Caterpillar Tractor Co., of Peoria, Ill. Each unit consists of a "Caterpillar" Diesel engine equipped with auxiliary fuel pump with one gallon overflow tank, close regulation speed governor and manual control, direct connected to an electric generator and assembled on a cast iron base. 60 KW, 40 KW, and 25 KW sets are included and each may be had in either D.C. or A.C. models. Copy of the booklet may be obtained from the manufacturers.

Curing Concrete Roads. A 32-page booklet presenting the practical advantages to be gained by the use of calcium chloride has been issued by Solvay Sales Corporation, 40 Rector St., New York. The booklet is intended as both a reference book and a practical, every day service manual that highway engineers and officials, contractors and supervisors will all find of definite value.

Vibrating Types of Materials Handling Equipment. Materials handling, electric vibrating equipment of the Jeffrey-Traylor type is featured in the new catalog 610 (64 pages), issued by the Jeffrey Manufacturing Co., Columbus, O. Catalog describes this equipment which has no mechanical wearing parts; gives specifications of the various types; deals extensively with typical installations covering feeding, screening, conveying, packing, cooling, drying and other handling operations.

Stabilized Roads. Literature containing many charts, tables and useful information on calcium chloride stabilized roads has been issued by the Columbia Alkali Corporation, Barberton, O. Address that company for copies.

Hercules Explosives and Blasting Supplies, just issued by the Hercules Powder Co., Wilmington, Delaware.

This profusely illustrated, 50-page catalog gives clear and adequate descriptions of a wide variety of dynamites for contracting, quarrying, mining and other uses; several grades of gelatins and semi-gelatins, including "permissibles"; black blasting powder in various forms; fuse, caps, squibs, blasting machines, and accessories. The first page is devoted to a table of general properties of dynamites and gelatins, while at the end is a complete index. Great care has been used in enumerating the uses to which each product is suited and likewise the uses to which it is not suited.